Biodiversity and amenity in urban parks and greenspaces

by

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This thesis is completely my own work except where acknowledged in the text. No part of it has been submitted for examination at another university and nor has it been published.

Abstract

Parks and greenspaces have many important roles for urban populations including recreation, exercise, supporting biodiversity, air pollution reduction and flood mitigation. However, parks and greenspaces are an easy target for budget cuts as there are no statutory obligations for their provision or maintenance. Various strategies are being used in the UK's cities to reduce the management costs of parks, for example reducing labour costs through less intensive management. There is a lack of understanding how these changing strategies and cost saving exercises will impact on parks, and the services they provide. What effects will these new management regimes have on parks and the benefits that they provide for people and wildlife?

These questions were tackled via three studies (as well as additional exploratory case studies), using approaches from life sciences, social sciences, geographical information systems and data science:

- The first study investigated how parks are managed in terms of mowing and planting schemes, and the effects that this has on a crucial ecosystem service, that of pollination. Local scale fieldwork results from the West Midlands were compared to national data. Pollinators were shown to prefer less intensive management.
- In the second study a national map of parks and greenspaces (Ordnance Survey, 2017) was compared to crowdsourced scenicness ratings (scenicornot.datasciencelab.co.uk, Data Science Lab, 2017) to investigate preferences for different categories of greenspace and management. More natural images of greenspaces were considered more scenic by visitors to the website 'Scenic or Not'.
- The third study evaluated public opinion of different types of habitat/management through a national online survey using photographs. Respondents preferred the less intensive forms of management.

This research demonstrates that less intensive management in greenspaces can be preferred by both human visitors and wildlife. This information is useful to greenspace managers in planning cost effective management which is attractive to people, and supports biodiversity and other ecosystem services.

1 BACKGROUND AND INTRODUCTION

"*The park nourished all the sleepers in the surrounding houses. It was the green heart. It gave the children dangerous bushes and heroic landscapes so they could imagine bravery. It gave the nurses and maids winding walks so they could imagine beauty. It gave the young merchant-princes leaf-hid necking benches, views of factories so they could imagine power. It gave the retired brokers vignettes of Scottish lanes where loving couples walked, so they could lean on their canes and imagine poetry. It was the best part of everyone's life."*

Leonard Cohen (1963)

Parks and other greenspaces are a key urban resource, providing a wide range of services to residents, and for the environment. For example, pollination, carbon sequestration and cultural services such as recreation. Parks are "vital places where people can connect with others and with the natural world, and improve their overall wellbeing" (Vergou, Bennellick and Boase (2019), foreword in Dobson *et al.*, 2019). Since 2010, the UK government has implemented a policy of "austerity" with the aim to reduce the budget deficit which followed the 2008 financial crisis. This austerity policy has involved large spending cuts and small tax rises (Oxfam, 2013). These austerity measures are ongoing and have impacted greenspaces through cuts to their management budgets, which has led land managers to seek various solutions to reduce costs. Public Health England (2020) note that "the financial climate continues to present a challenge and has found local government struggling to maintain their greenspace." If planned well, there is a possibility that a reduction in the intensity of management could allow more space for wildlife and ecosystem services. One key question is whether these changes would continue to provide recreation and aesthetic enjoyment. Some commentators, such as Sheridan (2016), recognise that whilst there are opportunities to reduce costs and benefit wildlife at the same time, there may also be pitfalls if changes are managed badly and have negative impacts for greenspace users. For example, some people may perceive the changes as ‘messy’ or unmanaged and this could discourage them from using the spaces and receiving the benefits of parks. However, biodiversity can contribute to the quality of a greenspace: “[p]oor quality spaces that are lacking in biodiversity and intimidating to reach will not support mental wellbeing or encourage use.” (The Parks Alliance, 2020).

Urban greenspaces are often ignored in relation to biodiversity or even actively criticised. For example, Gordon and Shirley (2002) suggest that parks under traditional management, with closely mown lawns, flower beds and regular pesticide use, are of little value to wildlife. It is important to qualify statements such as these. Some recent studies have shown that wildlife is thriving in urban areas, and sometimes even faring better than in the surrounding countryside. For example, Baldock *et al.* (2015) showed that bee species richness was higher in urban areas than in farmland or nature reserves. One reason that wildlife can fare better in cities is the fact that farmland is usually heavily managed with monocultures of crops or livestock and the application of pesticides.

Local authorities and other greenspace managers are currently making changes to their management practices, in particular reducing the intensity of management (Sheridan, 2016; Association for Public Service Excellence, 2018, 2019; Heritage Lottery Fund, 2014, 2016). There is an opportunity to investigate the effects of these changes on greenspaces, biodiversity and on their human visitors. This can then be used to inform practices and policy on management of these spaces.

My research focuses on developing an understanding of how changes in management practices in urban parks and greenspaces impact upon biodiversity, and whether there are trade-offs with their amenity value. This is important because parks are an increasingly important resource for urban populations (Heritage Lottery Fund, 2014, 2016), particularly those who may not have the resources to access nature beyond the city limits or pay for exercise facilities. Greenspaces also provide environmental services such as supporting biodiversity and reducing the urban heat island effect, which impacts upon the liveability of cities.

To answer the questions, I undertake a multidisciplinary approach that examines the relationships between park management, park users, biodiversity and the ecosystem services that biodiversity offers. Based on my experience of working in urban greenspaces, where I experienced the effects of reduced funding first-hand, the research focuses on detailed field work and analysis of local data in the West Midlands and uses analyses at the UK national level to understand how this fits into the national picture. Previous work has generally focused on one or two of the elements investigated here, for example biodiversity and park users' preferences or biodiversity and ecosystem services. A broader, multidisciplinary approach lays the foundations for a more holistic understanding that can account for the multifaceted, multirole nature of parks.

1.1 Research Question

Are changing management practices in urban parks and greenspaces affecting biodiversity, and are there trade-offs with amenity?

1.2 Aim of this Thesis

The aim of this research is to investigate how urban parks and greenspaces can be better managed to promote both biodiversity and amenity.

This project examines the types of management changes that are taking place, with case studies, and their impact on biodiversity and amenity. The results can be used to inform policy and better management by land managers, such as local authorities and nature organisations.

1.3 Research objectives

RO1. To identify the services/ecosystem services that urban parks already deliver (for example pollination and cultural services such as recreation) and determine to what extent they are underpinned by biodiversity.

RO2.To identify changes in management practices in urban parks (e.g. changes in mowing regimes, new types of floral display).

RO3. To investigate effects of changing management practices on biodiversity.

RO4. To investigate effects of changing management practices on amenity.

RO5. To investigate possible trade-offs between management practices that support biodiversity and other aspects of amenity.

1.4 Case Studies

This research uses case studies in greenspaces in the West Midlands where management changes are already taking place, as well as using data at the national level. Most greenspaces managed by Coventry City Council Parks Service have been mown less frequently since 2016, and many sites have had formal bedding replaced with naturalistic planting. Some flagship sites have continued to receive the previous management regimes and can therefore be used for comparison. ‘Pictorial Meadows’ (sown from proprietary seed mixes) have also been planted in some areas. Rugby Borough Council have also reduced mowing operations and changed the type of floral bedding in some beds and introduced Pictorial Meadows on verges. During the last 10 years Warwick District Council, which includes Leamington Spa and Warwick, have greatly reduced seasonal bedding, replacing with perennial beds and have left grass longer in some areas. There are also a range of exploratory case studies included in this research, for example data from Green Flag Award (the national standard for greenspaces) is used to compare horticulture and conservation standards.

1.5 The Three Studies

1. The Chapter 3 investigates changing management practices in greenspaces and their effects on ecosystem services. This was carried out through case studies using pollinator counts in the West Midlands where management has changed, for example new mowing regimes and changes to planting schemes. The local scale fieldwork results were compared to national data. This includes identification of ecosystem services (environmental benefits to people) and the biodiversity which underpins them (objective RO1), identification of changing management practices (objective RO2) and investigation of the effects of these practices on biodiversity (objective RO3).
2. In the Chapter 4, the first UK national map of parks and greenspaces, which was released in 2017 (Ordnance Survey, 2017), was compared to crowdsourced 'scenicness' (visual preference) ratings from scenicornot.datasciencelab.co.uk (Data Science Lab, 2017) to evaluate park users' preferences for different types of greenspaces and varying management regimes. The analysis was piloted with existing data from Scotland and London. The second study contributes to "investigate effects of changing management practices on amenity" (objective RO4) and "investigate possible trade-offs between management practices that support biodiversity and other aspects of amenity" (objective RO5) by investigating whether park users might have a preference for intensively managed or more naturalistic open spaces.
3. In Chapter 5, public opinion and park usage in different types of habitat/management type was evaluated in an online survey using photographs. This builds on the work in Chapter 4, to investigate effects of changing management practices on amenity (objective RO4) and investigate possible trade-offs between management practices that support biodiversity and other aspects of amenity (objective RO5) in greater detail.

2 A REVIEW OF CURRENT RESEARCH IN PARKS AND GREENSPACE

"*The measure of any great civilisation is its cities and a measure of a city's greatness is to be found in the quality of its public spaces, its parks and squares*"

John Ruskin (cited in Environment Transport and Regional Affairs Committee, 1999)

This literature review aims to introduce the key issues in relation to parks and greenspaces and to define the key terms. Here the challenges facing public parks and greenspaces are outlined, the key terms (for example park, greenspace and amenity) are explored and defined, the role of greenspaces for ecosystem service and biodiversity are described, and the interplay between biodiversity and amenity described. There is a lack of data available in relation to parks, this is outlined in the literature review and then investigated through exploratory case studies (Section 2.8) using data acquired by the author.

Further study-specific literature reviews are included in each of the main chapters which follow, these relate to each of the chapters' themes, methods and the issues raised therein.

2.1 Parks in crisis

"Baseline services are at risk of being withdrawn altogether, with the threat that our historic parks will once again become dirty and dangerous, and as users become discouraged, a spiral of decline will once again begin."

Layton-Jones (2016) *for The Gardens Trust.*

This review identifies that the funding of parks rises and falls and that, at the time of writing, is in a period of decline. As there is no statutory obligation for local authorities to provide parks, let alone maintain them to a high standard, they are an easy target for cuts to spending. This is in spite of the fact that they are well recognised for the many benefits that they provide, for health, the environment and society (e.g. CABE Space, 2004). The UK government reaffirmed that they do not feel it necessary to make parks a statutory function in their *Public Parks* inquiry as they were "not persuaded that such a statutory duty, which could be burdensome and complex, would achieve the outcomes intended" (House of Commons Communities and Local Government Committee, 2017). At a press conference during the coronavirus outbreak of 2020, UK Prime Minister Boris Johnson stated "It is very important for people's mental and physical wellbeing, that they should be able to get out and exercise ... many people do not have access … to private greenspace … and that's why parks, open spaces are so absolutely crucial for our country and our society" (Johnson, 2020). This demonstrates that the UK government does recognise some of the key roles that urban greenspaces play for citizens. Some funding from the government's 'Getting Building' coronavirus recovery fund has been allocated for parks, notably £23 million for a new city centre park in Manchester (Walker, 2020). But much more may be required to reverse years of decline.

The state of public parks and their funding is cyclical in nature, for example many parks were in decline during the 1980s and early 1990s, but experienced a 'renaissance' during the late 1990s and early 2000s with new sources of funding such as the Heritage Lottery Fund (Harding, 1999; Heritage Lottery Fund, 2014, 2016). Since around 2010, with the latest round of government cuts under the current 'austerity programme', parks have begun to suffer once more (Heritage Lottery Fund, 2014, 2016).

Layton-Jones (2016), in her report for The Gardens Trust, points out that this cycle of funding is not a new phenomenon - “[s]ince the nineteenth century, national government has championed parks’ value but missed opportunities to protect that value.” The Environment Transport and Regional Affairs Committee (1999) examined the decline in ‘Town and Country Parks’, finding that parks provided key infrastructure that was deserving of recognition and funding from both local and central government. The repeating pattern of decline was also seen during the previous major recession. In 1984 the journal *Landscape Design* included an article titled *Urban Parks in Crisis* claiming that urban parks needed funding for redesign to reduce costs and update them (Clouston, 1984). The Council of Europe Committee of Ministers to Member States on Urban Open Space (1986) stated that “economic recession, unemployment and consequent reduced opportunity for out-of-town travel have increased the need for the provision and enhancement of space in local neighbourhoods.” One interpretation of these reports is that parks tend to suffer just when people need them most. These concerns are evident as far back as the 19th century. In 1833 a government committee (Select Committee on Public Walks, 1833) investigated “the best means of securing open spaces in the immediate vicinity of populous towns, as public walks calculated to promote the health and comfort of the inhabitants”. This demonstrates that whilst the importance of open spaces has long been understood by government, this understanding has not necessarily been translated into legal protection, policy or practice.

The Heritage Lottery Fund (HLF, 2016) carried out a range of research to collate the *State of UK’s Parks Report* in an update to their 2014 research under the same title (Heritage Lottery Fund, 2014). The HLF recognise the problem of unstable funding whereby parks decline after several years of regeneration stimulated by funding from HLF, or other funding bodies. The

State of UK's Parks Report found that whilst people increasingly use their local parks regularly, the condition and budget of parks across the country has continued to decline. The Association for Public Service Excellence (2019) found that 82% of local authorities believe that budget cuts will have a disproportionate impact on parks and open spaces compared to other services and 100% of the local authorities surveyed believed that this would have health and social impacts. The HLF (2016) suggest that impacts, such as these, may be more pronounced in more deprived urban authorities and that, likely due to the North having a greater proportion of areas of deprivation, there is a north-south divide in the impacts. Their research included a survey of park managers, friends of the park groups and park trusts, and a public opinion poll giving an overview of the opinions of the key stakeholders in parks.

The government inquiry into parks (House of Commons Communities and Local Government Committee, 2017) led to the establishment of a Parks Action Group with representatives from various organisations involved in greenspace, including Green Flag Awards, Fields in Trust and the Parks Alliance. Parks and greenspaces were also assigned as a responsibility of a member of parliament, to address the lack of clarity in where this responsibility lay because parks issues span so many departments.

In its inquiry into parks provision, The House of Commons Communities and Local Government Committee (2016) implemented a survey which received over 130,000 responses. More than 50% of respondents stated that 'seeing nature' was one of their reasons for visiting parks, in fact this was the second most popular reason for their visits after 'going for independent walks'. More than 90% of respondents stated that their perceptions of their local parks were "very positive" or "somewhat positive". However, respondents were concerned that parks were entering a period of decline, as illustrated in these statements from respondents: "I am concerned about the gradual decline in standards due to funding being cut from central and local government", "[t]he parks community are extremely fearful that where we have increased the quality of our parks over the last 15 years, Parks will now slide back into decline once more and we will see the return of a more unhealthy and unattractive service which is low quality and not fit for purpose."

The current crisis in funding for parks and greenspaces has led many local authorities to review their management, with a view to reducing costs (Sheridan, 2016). This has driven the need to rethink the role of parks and greenspaces and led to some new, and sometimes radical, approaches to their management. Some of the more unusual approaches trialled include timber extraction and commercial cropping of star oil from Borage (NESTA, 2016). This general situation of budget reduction could stimulate innovation through the pressure to make savings and ultimately lead to smarter greenspace management. However, we currently lack the knowledge base that is necessary to allow effective implementation of strategies such as this. This research aims to contribute to filling this gap in knowledge.

2.2 What is a park/greenspace/open space?

Before examining parks and greenspaces, it is prudent to define what these areas encompass and how they are used. The Oxford English Dictionary (2016) defines a park as "*A large public garden or area of land used for recreation*" and The Town and Country Planning Act 1990 defines open space as "*land laid out as a public garden or used for the purpose of public recreation or previously used as burial ground*". These definitions provide a starting point but neither of these definitions characterise what the features of a park may be or how it might be used. They share the key themes of a garden or open space that is used for public recreation.

The terminology used to refer to public parks and other urban greenspaces is not well defined or consistently applied. Taylor and Hochuli (2017) found that less than half of the studies that they reviewed on “greenspace” actually defined the term. Public Health England (2020) also recognise the issues with consistency in the use of terms: “[d]efinitions of greenspace vary, and similar concepts can be described by different names within the literature”. Some of the other most commonly used terms for urban public green spaces are ‘park’ and ‘open space’. There is also an issue with aggregating and comparing existing research when there is not an accepted range of definitions.

In their report for IFPRA (International Federation of Park and Recreation Administration) Konijnendijk *et al.* (2013) stated that:

> “*Urban parks are defined as delineated open space areas, mostly dominated by vegetation and water, and generally reserved for public use. Urban parks are mostly larger, but can also have the shape of smaller ‘pocket parks’. Urban parks are usually locally defined (by authorities) as ‘parks’.*”

By specifying that parks are dominated by vegetation and water, this definition assists in characterising the areas that will be the focus of this research. However, there are issues relating to size as it is not clear what urban parks “are mostly larger” than.

The Heritage Lottery Fund (2013, cited in Dobson *et al.* (2019)) use the following definition: “A public park is an existing designed urban or rural park, the main purpose of which is providing free access to informal recreation and enjoyment. Our definition includes urban parks, country parks, gardens, squares and seaside promenade gardens”. This lists some types of parks and greenspaces but doesn’t tell us much about their features. Perhaps due to the focus on the diversity of areas with public access, this definition does not describe what these areas contain or how we would recognise the different types.

In the author's experience 'park' is sometimes used to refer to all public green spaces but is generally used to indicate relatively formal spaces which feature traditional management such as flower beds and closely mown grass. The terms 'greenspace' (or green space) and 'open space' can be used to encompass all types of public or green spaces in a city, which includes parks, as well as less formal spaces. For example, Coventry's Greenspace Strategy (Coventry City Council, 2008) encompasses various types of green open space and treats parks as a sub-category of this. Taylor and Hochuli (2017) state that "[g]reenspace is usually, but not always, comprised of vegetation and associated with natural elements." Urban open/green space is also used to include cemeteries, church yards, allotments, waste ground, railway and road embankments and verges, woodland, canals, rivers and open water (water is also sometimes referred to as blue space or bluespace). Taylor and Hochuli (2017) found that authors writing about ecology often use the term greenspace to mean 'park' as opposed to a wider definition including other types of greenspace. Some commentators also use the term 'open space' to refer to other types of public area, including civic spaces, such as town squares and shopping areas, though, due to their built-up character, these are less likely to harbour a significant biodiversity resource. However, they could still include some features of interest here, such as ornamental trees or flower beds.

There are various other terms relating to urban parks and greenspace, for example: play areas which generally have fixed play equipment such as swings, recreation or sports grounds dominated by sports pitches and games areas, and country parks which are usually larger sites on the urban fringe.

Country parks may or may not belong to the government accreditation scheme, which stipulates their minimum size and facilities (Natural England and Department for Environment, Food & Rural Affairs 2014), as the term can be used without official designation.

Coventry City Council (2008) use ‘greenspace’ or ‘green space’ interchangeably in their *Greenspace Strategy* as terms that encompass all of the green open spaces that they manage. In the *Greenspace Strategy* they cite the following as a definition, adapted by Institute of Leisure and Amenity Management (2001) from the Council of Europe Recommendation No. R (86)11 (Council of Europe Committee of Ministers to Member States on Urban Open Space, 1986):

> “*Urban parks and green spaces are an essential part of the urban heritage and infrastructure, being a strong element in the architectural and landscape character of towns and cities, providing a sense of place and engendering civic pride. They are important for enabling social interaction and fostering community development, as well as providing an outdoor classroom for biological and ecological studies. Public green spaces help to conserve natural systems, supporting ecosystems and providing the contrast of designed landscapes and conserved wildlife habitats within our urban settlements.*”

Although Coventry City Council (2008) cite this as “*the most complete description of green space*”, the definition describes the usefulness of these spaces rather than the physical features that they contain.

In their *Greenspace Strategy* Coventry City Council (2008) define 14 types of greenspace including premier park, area park, neighbourhood park, principal open space and incidental open space. From the author’s experience, these definitions are not necessarily consistently applied within this one city and can be problematic as they differ to those used in other cities. Other cities use similar typologies, but there is no consistent classification system applied nationwide. For example, what one council refers to as a park may be a referred to as a recreation ground by another authority. A lack of a standard typology for classifying parks introduces challenges when comparing those of different cities, and when comparing the work of researchers who have based their work on different locations.

The Department for Communities and Local Government (2006) defined a typology of open spaces of public value in its Planning Policy Guidance 17 (PPG17). PPGs were replaced by The National Planning Policy Framework (NPPF) in 2012 (Ministry of Housing, 2019). The Department for Communities and Local Government (2006) stated that PPG17's typology should "be used by local authorities when preparing assessments of need and audits of existing open space and recreational facilities." However, as demonstrated by the example of Coventry above, these are not necessarily applied, and are unlikely to be now that PPGs have been replaced, the NPPF does not provide such a typology. At the time of writing the planning system is under reform again, one of the aims claimed in the white paper is "more and better green spaces" (Ministry of Housing Communities and Local Government, 2020), it is not clear how this will be implemented.

A key aim of PPG17 was to help address the lack of data on greenspace. Local authorities were required to collect data on the quantity, quality and accessibility of their greenspaces, though there were no standards imposed at the national level. There was no national database of these findings, so they were only useful at the local level. There was also a recommendation that local authorities write a greenspace strategy and include greenspace in their local planning policies (Wilson and Hughes, 2011).

In 2006, only 45% of urban local authorities had audited their greenspace provision and only 30% had assessed future needs (National Audit Office, 2006). By the beginning of 2010, 62% of local authorities had adopted a greenspace strategy, but only 41% of these were based on PPG17 (Commission for Architecture and the Built Environment, 2010); therefore it is unclear what level of auditing occurred in those authorities who did not apply PPG17.

The PPG17 typology, The Department for Communities and Local Government (2006), is as follows:

"i. parks and gardens - including urban parks, country parks and formal gardens;
ii. natural and semi-natural urban greenspaces - including woodlands, urban forestry, scrub, grasslands (e.g. downlands, commons and meadows) wetlands, open and running water, wastelands and derelict open land and rock areas (e.g. cliffs, quarries and pits);
iii. green corridors - including river and canal banks, cycleways, and rights of way;
iv. outdoor sports facilities (with natural or artificial surfaces and either publicly or privately owned) - including tennis courts, bowling greens, sports pitches, golf courses, athletics tracks, school and other institutional playing fields, and other outdoor sports areas;
v. amenity greenspace (most commonly, but not exclusively in housing areas) - including informal recreation spaces, greenspaces in and around housing, domestic gardens and village greens;
vi. provision for children and teenagers - including play areas, skateboard parks, outdoor basketball hoops, and other more informal areas (e.g. 'hanging out' areas, teenage shelters);

vii. allotments, community gardens, and city (urban) farms;
viii. cemeteries and churchyards;
ix. accessible countryside in urban fringe areas; and
x. civic spaces, including civic and market squares, and other hard surfaced areas designed for pedestrians."

This typology has 10 categories which encompass the majority of public open space. Some of the categories could overlap, spatially as well as in their description, for example sports facilities and play areas are often contained within parks but they are largely discrete. This typology was used by Greenspace Information for Greater London (2018) in their Greenspace Map, which is used in Chapter 4 of this study. The separation of, for example, 'parks and gardens' from 'natural and semi-natural urban greenspaces' is useful as it allows comparison of formal and natural spaces.

It is also important that park users' interpretation of what a park is, and what it should be, is taken into account when defining a park because this may differ from how the land owner defines the site. Park managers may implement different management for a flagship park than a local greenspace. For example, the War Memorial Park in Coventry is classified in the *Greenspace Strategy* (Coventry City Council, 2008) as the "Premier Park". The War Memorial Park largely continues to receive the more intensive, traditional style of management whilst other sites such as "Neighbourhood Parks" have had their management reduced. Longford Park, for example, in the north of the Coventry has reduced mowing and the floral bedding styles have changed. But local people may expect that their local park, regardless of size or how the council classify it, to receive the same type of management as a high profile site. This study examines people's preferences for different management styles and therefore the possible impact of these changes on their enjoyment.

The Institute of Leisure and Amenity Management (1999) pushes towards an understanding of parks through use and amenity:

> "*the public's perception of what constitutes a park should be appreciated. This is almost certainly not confined to the major, designed and bounded green spaces named as parks on town and city maps. At least in the urban environment, many small open spaces are regarded by their local communities as parks, attaching to them the same purpose and expectations, particularly as safe places for children to play*."

User surveys carried out by local authorities could contribute to a broader definition of parks through contributing to and understanding the activities which residents engage in. For example, Haringey Council (2009) and Cheshire East Council (2014) had lists of activities which included: leisure, spend time with family and friends, walking, enjoy the natural environment, for exercise, take children, visit the playgrounds/recreational areas, dog walking, to improve health and wellbeing, peace and quiet, to enjoy scenery, attend events, part of travel route/shortcut, cycling, running/jogging, wildlife watching, fishing, education and 'other'. Parks and greenspaces are many things to many people, and these many roles need to be balanced with one another, as well as the other roles they play for the urban environment such as supporting biodiversity and broader ecosystem services.

Parks and greenspaces are a constant, just around the corner when we need them, they sometimes appear to take care of themselves, so they are easily forgotten until there is a problem. Issues caused by a lack of funding may take time to become apparent in parks. For example, cuts to staff leading to a public library closure would have an immediate impact on users, cuts to park staff may only become apparent through a slow decline in standards of maintenance.

It is obvious from these definitions of parks and greenspaces, that there is not a single typology that is consistently applied. This creates a challenge for those researching or promoting greenspace as it is hard to carry out effective comparisons. The variety of definitions is indicative of the alternative perceptions of funders, managers and the public; for example, the contrast between the opinions of park managers and park users, or those of different groups of greenspace visitors. This is due to greenspaces' multifaceted and multiuse natures; this makes defining them a challenge in itself.

In this study, from here onwards, the term 'park' will be used to refer to a formal subset of public greenspaces generally featuring flower beds and mown grass, but not to sites such as urban nature reserves and cemeteries. Other types of greenspace may still be used by the public for recreation but are not considered parks. The terms 'greenspace' and 'open space' will be used interchangeably to refer to all types of urban green open spaces to which the public have free access, including parks, woodlands, nature reserves, cemeteries, waterways etc. but will exclude open spaces that are not significantly green such as town squares and other civic spaces, which are not the immediate focus of this research.

2.3 What is amenity?

Urban parks and greenspaces offer a range of opportunities to residents which can be broadly described by the term amenity, it is a subjective term affected by a range of factors. Oxford English Dictionary (2016a) defines amenity as *"[a] desirable or useful feature or facility of a building or place"* or *"[t]he pleasantness or attractiveness of a place".*

In this section a definition is sought for amenity, in particular in relation to greenspace. These dictionary definitions are a good starting point but they are somewhat subjective. The first mentions usefulness, but what is useful to one person may not be useful to another. For example, if one wants to go running one might be looking for suitable paths, whereas a parent might be looking for safe play opportunities. The second definition is similarly subjective, one person may enjoy open views, another might prefer woodland, this could also be affected by the person's cultural background or their previous experience, for example their experience of wild areas outside of the city such as national parks (Mahmoudi Farahani and Maller, 2018).

'Amenity grassland' is a term commonly used when describing much of intensively managed parks. 'Amenity' in this term refers to its usefulness for recreation. 'Amenity grassland' was added as a habitat category in the Phase 1 survey methodology in 1986 (Joint Nature Conservation Committee, 2010) and the Phase 1 methodology handbook points out that this is the prevalent form of open land use in urban areas. In the Phase 1 survey guidelines, amenity grassland refers only to regularly and closely mown grassland. Grassland under alternative forms of management would be described by another of their categories, for example 'improved grassland'. The Phase 1 handbook also states that amenity grassland is of limited value to wildlife, but that reduced mowing, even if it was just of the edges, could improve both public enjoyment and conservation value and that "[t]he large extent of amenity grassland, clearly visible on urban habitat maps, often contrasts markedly with the much smaller areas of semi-natural habitat, making clear the need to conserve the latter."

Recreation is a key aspect of amenity and of the role of urban greenspaces. Christian *et al.* (2013) suggest that recreation is key to greenspaces' value "[t]he long-term value and function of urban green spaces can be attributed to their potential to support recreation activity, which in turn contributes positively to the wellbeing and health of urban populations." The Department for Communities and Local Government (2006) point out that even those that do not actively use urban open spaces can benefit from their "visual amenity" and that these open spaces contribute to "urban quality" and regeneration.

In his study of the amenity value of nature, Gibbons (2011) reminds us that, as well and recreation and leisure, there are various other amenity benefits that can be conferred by nature such as "opportunities for green exercise, visual amenity, mental or psychological well-being, source of inspiration, wildlife viewing, ecological education opportunities, etc." Gibbons (2011) states that these benefits can also be referred to as 'cultural services' of ecosystems.

In 1996 the (non-statutory) Accessible Natural Greenspace Standard (ANGSt) guidance was issued by Natural England for public access to <u>natural</u> greenspace (Natural England, 2010). This guidance suggests maximum walking distances for residents to natural greenspaces of a particular size. This relied on small scale pilots and surveys to define acceptable walking distances and accessible natural greenspace. ANGSt recommends that everyone, wherever they live, should have an accessible natural greenspace:

- "of at least 2 hectares in size, no more than 300 metres (5 minutes walk) from home;
- at least one accessible 20 hectare site within two kilometres of home;
- one accessible 100 hectare site within five kilometres of home; and
- one accessible 500 hectare site within ten kilometres of home; plus
- a minimum of one hectare of statutory Local Nature Reserves per thousand population."

Similarly, in the EU the European Environment Agency (EEA) sets a 'green space provision target' that people should have access to green space within 15 min walking distance (Gordon & Shirley, 2002). Further information on this target could not be found, suggesting that it is considered a low priority by the EEA or that the target has since been rescinded.

PPG17 refers to a category "amenity greenspace" which includes informal recreational spaces, often around housing. Amenity is a way to describe the usefulness of greenspace in terms of human experience. It also relates to their management, for example 'amenity grassland' as a description of intensively mown grass. Greenspaces' usefulness for various forms of recreation is a key aspect of their amenity, which includes enjoyment of scenic views and watching wildlife.

2.4 Urban Biodiversity and Ecosystem Services

"*In merging nature and culture, the most successful cities combine such universal needs as maintaining or restoring contact with the cycles of nature, with specific, local characteristics.*"

Kitt Chappell (2007)

The above quote sets the challenge for planners to introduce or encourage nature and naturalistic features in a way that engages with the culture of the city, so that they are enjoyed by its residents, whilst also maximising the ecosystem benefits which they provide.

Urban populations and environments benefit from the inclusion of natural areas and features in various ways. For example, "[e]nhancing urban areas may require the introduction of trees and other vegetation as well as introducing colour, light and shade, which promotes "nature" and brings a habitat for wild life in urban areas" (Council of Europe Committee of Ministers to Member States on Urban Open Space, 1986). Approaches to urban nature, such as this, suggest that amenity/beauty and nature/wildlife both make valuable contributions to the urban fabric and that both can be promoted through the careful introduction of vegetation. A recent study found that there is a relationship between how often people visit nature and pro-environmental behaviours such as recycling, buying eco products and walking/cycling (Alcock et al., 2020). The amount of neighbourhood greenspace was also associated with increases these behaviours. This suggests that access to greenspace fosters an appreciation of nature and leads to greater care for it, so that the environment benefits as well as the resident.

Lawton, *et al.* (2010) describe biodiversity as "a convenient technical term that has entered broader usage to capture the diversity of the whole living world, from genes and individual species, through to plant and animal communities and entire biomes". Biodiversity, put simply, is the diversity of living things, both within and between species, and their interactions. Biodiversity underpins ecosystems and the associated cycles which support life on earth, including life in cities.

Biodiversity is not often something that springs immediately to mind when thinking about cities. Their vast tracts of concrete and tarmac seem hostile to life, and urbanisation has direct impacts on natural systems, which leads to various challenges for people and biodiversity, for example by leading to habitat loss and pollution (McKinney, 2002). More than half of the world's population now live in towns and cities, and this continues to rise (United Nations, 2014). In the UK 83% of people live in urban areas (World Bank, 2018). Therefore, towns and cities are where most people are most likely to have opportunities to encounter wildlife. The role of greenspace in providing access to nature is well recognised, for example, by the House of Commons Communities and Local Government Committee (2017) “[p]arks and green spaces, particularly those in urban areas, are vital for providing access to nature and opportunities for people to enjoy wildlife. Biodiversity also contributes to the health of cities and wellbeing of their residents in a number of ways through the ecosystem services which it supports (Taylor and Hochuli, 2015).

As Sheridan (2016) points out, even within built up urban areas there are still spaces for wildlife “[l]ocal green spaces, especially parks and gardens, allotments, cemeteries and churchyards, have become refuges for much surviving wildlife.” Similarly, in a memorandum submitted by the Wildlife Trusts and Urban Wildlife Partnerships to The Environment Transport and Regional Affairs Committee (1999) (for their report into parks) the importance of parks in maintaining biodiversity was stressed:

> *"Parks may include wildlife habitats or provide opportunities for the creation of naturalistic habitats ... Larger parks ... are an important element in the network of urban green space, providing links between isolated pockets of biodiversity in the countryside for wildlife to migrate along ... The crucial role of parks has been acknowledged by wildlife experts as witnessed by their inclusion in a number of Biodiversity Action Plans"*

The Department for Communities and Local Government (2006) also echoes this sentiment stating that open spaces are “havens and habitats for flora and fauna: sites may also have potential to be corridors or stepping stones from one habitat to another and may contribute towards achieving objectives set out in local biodiversity action plans.”

This biodiversity resource is of increasing importance to urban populations, The Institute of Leisure and Amenity Management (1999) point out that public interest in, and concern for, the environment is on the increase and that this results in a requirement to "focus on the benefits of conserving living green spaces within the urban environment" also due to their capacity to assist with the reduction of noise and air pollution. They also touch upon the role of parks in maintaining the carbon water cycles (principally due to their trees and water bodies). These processes are collectively referred to as ecosystem services, broadly speaking these are the benefits that humans receive from ecosystems. The Parks Alliance (2020) also describe a range of ecosystem services provided by greenspace, including: mitigation of the urban heat island effect, absorbing CO_2, reducing flooding and air pollution, and improving water quality)

Similarly, Lawton *et al.* (2010) define ecosystem services as a range of benefits provided by the natural environment from the "obvious things" such as food, materials and water, to more complicated services such as the effect on the climate of carbon sequestration and flooding through storage of water. They also describe the "less tangible aesthetic and recreational services", such as places for relaxation and exercise. Many of these ecosystem services derive from natural processes such as nutrient and water cycles. Lawton, *et al* (2010) state that biodiversity is key in underpinning ecosystem services and that it "plays a critical role in all of these processes and as a result is often viewed as the vital underpinning for most, if not all, ecosystem services." Similarly, Balvanera *et al.* (2006) demonstrated a positive correlation between biodiversity and ecosystem services. This suggests that more biologically diverse greenspaces could lead to a healthier city overall and that promotion of biodiversity in greenspaces will foster ecosystem services.

The Millennium Ecosystem Assessment (2003) defined four categories of ecosystem services “provisioning, regulating, cultural, and supporting services”. Urban greenspaces can provide many of the suggested benefits across each of these categories, for example:

- *Provisioning services*: in urban greenspace this could include fruit from trees, or vegetables from community growing projects.
- *Regulating services* include: regulation of climate and water by reducing the urban heat island effect and storing storm water to prevent flooding, water purification and pollination (many species of pollinators do better in cities (Hall et al., 2016)),
- *Cultural services*: aesthetic (making cities more attractive), education (greenspaces’ proximity to where most people live allows them to provide a range of opportunities for formal and informal outdoor and environmental education), recreation (e.g. sport, walking, wildlife watching), spiritual and inspirational (e.g. allowing a connection to nature), and greenspaces contribute people’s ‘sense of place’ and cultural heritage (some parks have a rich history).
- *Supporting services*: urban greenspaces underpin soil formation, nutrient cycling and primary production.

A single greenspace can provide a range of ecosystem services. Lawton, *et al.* (2010) point out that there is an ongoing increase in pressure on land and water and that this necessitates finding ways that resources can deliver “multiple benefits”. They give some examples related to farming, an alternative urban example could be a park which provides habitat for wildlife and flood water storage whilst still providing good opportunities for recreation.

Lawton, *et al.* (2010) suggest that radical changes are required in the way we manage land for nature:

> *"we need a step-change in our approach to wildlife conservation, from trying to hang on to what we have, to one of large-scale habitat restoration and recreation, under-pinned by the re-establishment of ecological processes and ecosystem services, for the benefits of both people and wildlife."*

It is imperative that this change of approach suggested by Lawton occurs in urban areas as these are the places where most people live, and so this offers the opportunity to allow access to and appreciation of nature whilst ameliorating against some of the impacts of human activity.

Habitat connectivity is a key issue for urban greenspace to contribute to conservation of biodiversity. Lawton, *et al.* (2010) state that "[e]cological networks have become widely recognised as an effective response to conserve wildlife in environments that have become fragmented by human activities." Ecological networks consist of a collection of sites containing the area, connectivity and diversity to support species and enable successful dispersal. Lawton et al. (2010) go on to state that provision of ecological networks "will deliver a range of benefits for people as well as wildlife, because of the range of ecosystem services that resilient, coherent ecological networks can provide."

Urban parks should contribute to England's ecological networks. Lawton *et al.* (2010) claim that enhancing the resilience of these networks requires that they are "*more*, *bigger*, *better* and *joined*." This includes increasing the area of wildlife sites. Why not re-designate some urban greenspaces as wildlife areas, design any new spaces with nature in mind and implement less intensive more naturalistic management? Thus, whilst increasing the area managed for nature, urban sites could also contribute to improved connectivity, acting as stepping stones that allow nature to penetrate and traverse cities, and bringing wildlife closer to where people live. Lawton *et al.* (2010) further state that many of the existing wildlife sites in England are too small and that connectivity is poor, leading to isolation of sites and that “too few people have easy access to wildlife”. Urban sites could contribute to improving all of these issues, particularly by improving access for people. Similarly, the House of Commons Communities and Local Government Committee (2017) suggest that we should understand “parks as part of wider networks of green infrastructure” and that this “helps to highlight the value of green corridors and networks for biodiversity, wildlife, and active travel networks.”

Urban habitats are presently under studied. A review of the literature by Corbyn (2010) found that only one in 6 ecological scientific papers concerned environments used by humans, of which the majority related to agricultural land. Only 3% of papers focussed on urban areas and 1% on suburban areas (Corbyn, 2010). As discussed earlier in this section, there is a lack of research investigating urban and greenspace ecology. Nielsen *et al.* (2014) point out that key ecological theories and methods can be applied to urban parks, in spite of the fact that their habitats differ from those found natural areas. They state that the main weakness of existing studies into urban ecologies is the focus on single species or a small number of species, and that they have rarely included both flora and fauna. Nielson *et al*. suggest that “[a]dopting 'multi-species group' approaches in future research is needed to further advance the understanding of the overall biodiversity of urban parks, and its drivers.” This study addresses aspects of this challenge by examining relationships between pollinators and planted flowers in urban greenspaces, and human enjoyment of these spaces. Pollination is listed by The Millennium Ecosystem Assessment (2003) as a regulating service. It also contributes to provisioning, through pollination of food crops, as well as cultural ecosystem services through people’s enjoyment of seeing pollinators. Cultural ecosystem services are a key theme of this research, through people’s visual enjoyment (scenicness) and preferences for different styles of management in greenspaces.

2.5 Parks management and biodiversity

"*Parks and green spaces should be managed to encourage connections with nature. A wide range of habitats should be provided to give visitors the opportunity to engage with and better understand the natural world. This in turn will maximise the wellbeing benefits associated with nature connectedness."*

Dobson *et al.* (2019)

Parks and greenspaces have many roles to fulfil. Can they serve both biodiversity and amenity? Burgin (2016) succinctly sets out what is required of urban planners in relation to biodiversity: "the challenge is to recognise that biodiversity conservation is critical to sustainable cities, and to develop approaches to restore and conserve this important component of urban sustainability." However, the importance of urban greenspaces and biodiversity is rarely recognised and it is under investigated. Urban open spaces are traditionally often neglected in discourses regarding biodiversity, as Sheridan (2016) puts it "[t]he significance of urban green space is largely ignored by biodiversity and countryside management professionals despite its importance." Taylor and Hochuli (2017) found that only 28 out of 125 journal articles relating to greenspace that they reviewed mentioned biodiversity. This oversight is unfortunate, as they are particularly important to city dwellers to allow access to wildlife, and, as The Institute of Leisure and Amenity Management (1999) point out, they do have a contribution to make biodiversity "[t]he creation and conservation of wildlife habitats in urban spaces contributes to the UK targets for biodiversity."

On the other hand, Gordon and Shirley (2002) claim that urban greenspaces' "environmental credentials are less well established." They assert that the features that are aesthetically pleasing to many people, such as formal flower beds, expanses of lawns and sport pitches, are of little value to wildlife due to the fact that they are usually intensively managed, which "typically includes liberal applications of herbicides and pesticides and the masking, if not destruction, of natural features and habitats." What is *actually* attractive to park users is investigated in this study, as is the usefulness of these intensively managed habitats to wildlife. Gordon and Shirley (2002), concede that even parks and open spaces that have been subjected to this type of management "provide relief from the built environment in many densely developed towns and cities, and at least limited habitats for wildlife to exploit." Sheridan (2016) echoes this sentiment, to a degree, when they state that "[t]he role of local green space as a mosaic of habitats and as sanctuaries for wildlife is now emerging as a major justification for the changing management of many sites -- but most are still sterile 'green deserts' of 'neat' grassland, especially in residential areas." One might argue that Gordon and Shirley's view is overly bleak, some species are thriving in our cities. Unsurprisingly generalist species such as feral pigeon and fox do well in urban areas, but some of the species doing well may be more surprising, for example peregrine falcon live at higher densities within cities (BBC, 2016). Many varieties of pollinators are thriving in urban areas, including some of the rarer species (Baldock *et al.*, 2015). It is perhaps time to change the paradigm of cities as "biological deserts" (Hall et al., 2016). Only then can the interventions required to safeguard and improve their biodiversity be realised.

There are opportunities to increase biodiversity in urban greenspace; even small changes in management, such has reduced mowing, could have sizeable effects on biodiversity. For example, Sheridan (2016) states "[r]ough grassland/tussocky grass areas have 3 times more pollinator species than standard mown grass." This is an important finding as pollinators are in decline, and they are essential to many elements of our food supply. Sheridan also emphasises that, for pollinators at least, it is not important whether wildflowers are native or not, and also that some plants which are often seen as weeds, such as ragwort, clover and ivy can be key to pollinator survival. He goes on to suggest that traditional 'tidy' grounds maintenance has contributed to the decline of pollinators. Perhaps a move away from traditional manicured parks could help halt their decline. Small changes in mowing regimes could have a positive impact "even where a short sward is necessary, some relaxation of mowing frequency may be possible and should reduce management costs. (Department for the Environment Food and Rural Affairs, 2016). For example, dandelion and clover will flower in a short sward, and are visited by a range of pollinators. Dandelion also flowers early in the season, so it provides an important pollen and nectar resource to pollinators emerging from hibernation (Department for the Environment Food and Rural Affairs, 2016).

Whilst there is potential to increase biodiversity in cities, biodiversity is often not a key consideration for those responsible for planning how land is managed as amenity and recreation often take precedence in greenspace. Flores *et al.* (1998) stated that "[a]lthough a modern ecological framework exists, inappropriate or outdated concepts continue to be used in the context of land-use decision making." However, recognition that biodiverse landscapes confer greater benefits to city residents is rising. For example, Fuller *et al.* (2007) found that the open spaces that are rich in species have a greater positive psychological impact. Interestingly, they also found that visitors to greenspace were generally able to make some assessment of species richness. Conversely, Qiu, Lindberg and Nielsen (2013) found that visitors to parks usually preferred a more open setting (which often harboured less biodiversity), but ecologists participating in the same survey preferred more biodiverse parks. This suggests that knowledge of biodiversity can increase appreciation of it. Therefore, engaging and educating people in biodiversity could help to develop their preferences for biodiverse spaces.

Traditional parks management in the UK usually consists of turf mown on a regular cycle, often around every ten days in summer. Trees are crown lifted to allow easy access for the machinery and any hedges cut by a tractor mounted flail once or twice per year (outside of the bird nesting season). Seasonal flower beds and shrub beds are also common in parks and these are replanted or trimmed on a regular schedule. This management is often laid out in a set of standards which stipulates the frequency of various maintenance operations or the resulting standard, such as mowing frequency or grass length (e.g. Charnwood Borough Council, 2016, Salford City Council, 2016). There are various models for the maintenance and management of parks and greenspaces and different cities have their own systems. These may include a service level agreement between the parks service and another council department who carry out the maintenance, an in-house parks maintenance team or an external contractor. In some cases a management agreement will exist with a third sector organisation such as a charity or 'friends of' group. Sometimes management even varies within the same city, for example, until recently, Coventry City Council used an internal team for most greenspace but city centre greenspaces were managed by an external contractor (but this has now been brought back in-house).

Newer styles of management include naturalistic plantings, which appear similar to natural habitats rather than regimented flower beds. But these more natural styles are not an entirely new feature of parks. Dunnett and Hitchmough (2004), leading proponents of naturalistic planting, point out that this style was established by the end of the nineteenth century, but formal planting has remained a key management type in urban parks. The use of these less intensively managed and more natural looking styles of planting are now more attractive than ever to park mangers whose budgets are currently under pressure.

How changes, including naturalistic plantings, impact park managers and users is not well understood. Sheridan (2015) laments the lack of existing information about how to better manage parks when funding is scarce: “There is little available research, guidance or general agreement on new models for management and maintenance in order to cope with the reduced funding available.” He also decries the increase in contracting out of maintenance, with low margins and short contracts, leading to poor continuity, low standards and disruption. Dobson *et al.* (2019) also point out that there is a lack of evidence on the social impacts of changes in greenspaces, including the effects of changing horticultural management. The current study investigates how changes in management that are occurring under these conditions are affecting both people and wildlife.

Sheridan (2016) points out that the “prevailing gardenesque/horticultural paradigm of neatly cut grass, flowers, clipped shrubs and hedges is still locked into most people’s consciousness”. One might ask whether this ‘paradigm’ is locked into the consciousness of everyone or is it only park managers? Sheridan (2016) goes on to question whether it is “time now for a paradigm shift”. Although Sheridan feels there will always be “a place for good horticulture and floral displays” and a need for lawns for sports, picnics and relaxation, he questions the need to apply horticultural standards across the board. Sheridan highlights the fact that most of the SLA’s (service level agreements) and specifications for grounds maintenance have not been substantially updated since the 1980’s. He states that large portions of parks are not really used for recreation and questions the prudence of applying the same standard of “neatness” to whole parks and road verges, in fact “[t]here are very good sustainability and biodiversity reasons why we shouldn't cut it all" (Sheridan, 2016). Good management of sites continues to be key. The Scottish Executive Central Research Unit (2001) assert that "the long term value and quality of open space depends more on effective management and maintenance, together with strong community support, than the planning system."

Evidence is required to inform management which supports pollinators as well as enjoyment by human visitors, and is also cost effective, as Turo and Gardiner (2019) put it, "[w]hen designing urban bee habitats, ecologists must optimize pollinators' needs in a manner that both is economically feasible and respects societal norms and values." Parks management that promotes biodiversity may also reduce costs, which is an attractive prospect for parks managers in these austere times. Sheridan (2016) suggests that long grass regimes can reduce costs and help wildlife and also points out that mowing directly kills wildlife, in particular pollinators. Though he does point out that a change in mowing regime may require an investment in different machinery. Similarly Burgin (2016) states that "green urban infrastructure including parks and gardens, 'backyards', remnant bushland and even wastelands can be more effectively developed to sustainably support biodiversity, typically at reduced on-going cost." Burgin gives the example that converting huge expanses of lawns (which are basically equivalent to desert for the majority of native species) to meadow could provide habitat and promote biodiversity. She does go on to caution that, because of limited understanding and problems with invasive species, the focus has previously been on a narrow section of total biodiversity and that "these changes in species' dynamics often lead to the decline of local amenity for humans, and endemic species." There is also a risk that other taxa are neglected due to their problematic or easily overlooked natures. She cites an increase in nuisance species, including native species which have become more abundant. Raising awareness of the problems caused by “homogenisation of landscapes” is key: “to ignore the impacts on biodiversity in urban areas typically results in on-going expenditure to deal with, for example, over-abundant (often feral) species, and does not truly provide sustainable cities” (Burgin, 2016).

Naturalistic management can be considerably cheaper. The Woodland Trust (2011) found that annual cost per hectare for maintaining amenity grass ranged from £1620 to £2280, while meadow grassland and rough grassland cost £710 and £580 respectively. However, Kendle and Forbes (1997, cited in Nam and Dempsey (2019)) state that naturalistic management styles, namely meadows and long grass, are not always cheaper as they can require more complex management. For example, new machinery and collection of the arisings from mowing can be required to deal with longer grass.

Greenspaces have potential to promote biodiversity, but McDonnell and Hahs (2014) point out that that there are various issues associated with planning of management to prevent further biodiversity loss in urban areas including: linking management with ecological understanding, protecting remaining natural habitats, restoration of damaged habitats and integration of fragments of habitat into the landscape. They go on to point out that this is problematic because urban biodiversity is “relatively understudied”. This results in management decisions on urban biodiversity being based on a less than complete knowledge base. More local ecological data from cities is required for more robust management planning. According to Sweeney, Engindeniz and Gündüz (2007) the homogenisation and fragmentation of habitats are key urban habitat issues and generally, the proportion of non-native species increases toward the centre of a city. “Implementing regional biodiversity conservation strategies will require new interdisciplinary collaboration to achieve both the biophysical and socio-economic quality of life characteristic of a sustainable future.” (Sweeney, Engindeniz and Gündüz, 2007)

Sheridan (2016) suggests an overhaul of how council's grounds maintenance contracts are managed. He suggests that longer contracts would support investment and reduce disruption. Standards should be based on outcomes and outputs as opposed to frequency of operations, and should not be based only on traditional horticultural standards and practice. Flexibility, innovation and partnership working are required. Any changes should be trialled and the public should be consulted, or at the very least informed. He suggests investment in wildflower and prairie-style planting will save money in the longer term and that parks should promote biodiversity. Savings should be invested in parks facilities (in the author's experience, this is often not the case with local authorities, savings and income are often absorbed into a central pot).

Local authorities across the UK are trying various schemes to reduce the costs associated with managing parks. Sheridan (2016) states that "[m]any councils have experimented, some extensively, with 'differential mowing regimes', wildflower and naturalistic meadow plantings, but usually on a small scale as a percentage of their entire land holdings, often for cost-cutting reasons." Some of the resulting changes in management practices have the potential to increase biodiversity. The Association for Public Service Excellence (2019) found that 47% of local authorities stated that they had reduced bedding/flower displays between 2018 and 2019 and 27% had reduced grass mowing frequency. *Burnley Go to the Park* (NESTA, 2016) made 6 main changes to cut costs including: introducing meadow management and conversion of annual bedding to perennial planting. These changes are saving money, but could also have other positive effects, for example increases in wildlife and improved ecosystem services. "Burnley Go to the Park has made savings of nearly £70,000 since its launch and is forecast to save the council 10 percent of their parks budget by 2020" (NESTA, 2016).

One possible objection to more naturalistic management of parks is that they could 'look messy' or feel less safe. This depends on park users' preferences, which are shaped by many factors, including culture and what they are accustomed to. Whilst perceptions of the environment are changing, and there is an increasing interest in nature, residents may need to get used to park management that is moving away from the traditional 'mown grass with emergent trees'. Özgüner and Kendle (2006) found that the residents want access to both naturalistic and formal landscapes and that whilst they appreciate natural landscapes, they want to be able to see that they are managed. Residents may need to be educated as to the advantages of biodiverse open spaces to appreciate them better, as Sheridan (2017) puts it there is a "need for a national campaign to change perception from 'untidy mess' to 'wonderful habitat'"

In many cases, biodiversity may increase amenity, for example by creating more beautiful landscapes, but at times there will be conflicts, for example longer grass might be unsuitable for a picnic or a ball game, park users may complain about their dog getting muddy in a new wetland (and at the same time the dog may be stirring up sediment and disturbing the wildlife), or parents may worry about their children playing near water. Any projects to improve biodiversity in parks must be sensitive to current community use and will require consultation, and perhaps education, for them to be a success.

For pollinators in particular, seasonal floral bedding displays, which are stripped and replanted two or more times per year, can have some value. "Traditional bedding can be valuable for pollinators if the right plants are chosen. Highly bred varieties are often less suitable, especially 'double' flower varieties, which have extra petals and produce less pollen and nectar." (Department for the Environment Food and Rural Affairs, 2016). However more natural plantings have been shown to have greater value "[t]here was, however, a greater abundance of total pollinators recorded on native and near-native treatments compared with the exotic plots." (Salisbury *et al.*, 2015). The work of Salisbury's *et al.* (2015) involved test plots similar to domestic garden borders, the current study builds on this by using real world examples in urban parks. Salisbury *et al.* (2015) found that some species of pollinators prefer native plantings but non-native mixes could be useful as they extended the flowering season and were particularly useful to more generalist species. A long flowering period is good for pollinators and also aesthetically for human park visitors. As one would expect, in Salisbury *et al.*'s (2015) study, more flowers led to greater numbers of pollinators "greater floral resource resulted in an increase in visits". Whilst this principle is intuitive, it is worth bearing in mind for park managers who may be considering replacing flower beds with non-flowering shrubs, or simply returning them to turf.

Climate change and its effect on phenology are another argument for biodiverse parks:

> *"Climate change has the potential to alter the phenological synchrony between interacting mutualists, such as plants and their pollinators. However, high levels of biodiversity might buffer the negative effects of species-specific phenological shifts and maintain synchrony at the community level, as predicted by the biodiversity insurance hypothesis."* (Bartomeus et al., 2013)

The urban heat island effect affects phenology, though greenspace does reduce the warming effects to some degree. The main difference, demonstrated by remote sensing studies, is a longer growing season, which could have a positive effect on pollinators if it also translates into a longer flowering season (Zipper et al., 2016; Dallimer et al., 2016). This could explain, to some extent, why pollinators seem to be faring better in urban areas than in more rural settings (Baldock et al., 2015a; Hall et al., 2016). However, there are potential problems if pollinators are not able to adjust their life cycles according to changes in flowering periods (Bartomeus et al., 2013). For example, a key nectar resource for a particular species could flower before the insects emerge from hibernation, this could reduce resources available to a proportion of pollinators as species phenology can change at different rates (Memmott et al., 2007). An American study has shown that this is not always the case for some generalist species where the plants and pollinators phenology changed in response to climate change at a similar rate (Bartomeus et al., 2011).

It is also important that parks mangers consider climate change in their planning "[g]iven the rapid pace of urbanization and ongoing climate change, understanding how vegetation phenology will alter in the future is important if we wish to be able to manage urban greenspaces effectively" (Dallimer et al., 2016). This presents another challenge for managers who are already dealing with budget pressures. Well planned naturalistic planting is one way to meet this challenge (Alizadeh and Hitchmough, 2019).

Another possible argument against using biodiversity measures to reduce grounds maintenance costs is that it could put jobs at risk. However, an alternative way to look at this would be that it could free up resources for other projects. As Purnell, cited in Jefferies' (2016) article about automation of tasks in the public sector, puts it "what we need is the people who are doing tasks that are fairly dull and don't need much skill freed up to attack the real infrastructure problems, of which there are hundreds upon hundreds that we're burying our heads in the sand about." Or another way to look at it is that parks departments *are* facing cuts, whether one agrees with this or not, and it might be possible to reduce costs with fewer negative impacts on the quality of greenspaces. Less intensive forms of management, used to promote biodiversity, could be a way to avoid what Gordon and Shirley (2002) describe:

“[i]n periods when resources were short the quality of this type of [intensive traditional] management suffered, and many parks became little more than gang-mown prairies with ageing trees and derelict infrastructure.” Yet another way to look at this is that austerity may, in some cases, be driving innovation in grounds maintenance and landscape design and, perhaps, that some of the changes should have been trialled by now anyway. Unfortunately local authorities can tend to be set in their ways. Leslie (2008) states that graduate trainees find local authority employers “staid” and, in the author’s experience of parks departments, it can be difficult for new ideas to gain a foothold especially when they do not come from the management. But local authorities are being forced by austerity to try new ways of working, which may sometimes lead to more opportunities for biodiversity.

There is a some disagreement in the literature about the current value of greenspace for biodiversity. However, it is clear that greenspace management is changing in response to budget pressures and there opportunities to minimise any negative impacts of these changes and increase the postive impacts. There is a gap in knowledge about whether the changes being made in greenspaces are positive for biodiversity *and* for people. This research aims to investigate this through the preferences of pollinators and human greenspace users.

2.6 Conflicts between biodiversity and amenity

“*Landscape architecture can be a charged discipline, especially when it has to resolve the competing interests of its human clients with those of the other organisms that seek to inhabit the same space.”*

Del Tredici (2014)

The House of Commons Communities and Local Government Committee (2017) states that whilst the amenity and leisure value of parks is important, this alone cannot reflect their wider value, nor their contribution to agendas at the local and national level. As outlined previously, parks and greenspaces have many roles to fulfil which, at times, will inevitably lead to conflict. The Council of Europe even go so far as to say that dealing with this contention is the main consideration in greenspace management: “[m]anaging urban open space is principally to do with managing conflicts” (Council of Europe Committee of Ministers to Member States on Urban Open Space, 1986). They go on to point out that those involved in caring for these spaces must understand what activities they are actually used for and that “only by recognising the multifunctional demands” placed on these areas they can be better equipped to decide whether these resources are adequately protected. Biodiversity and amenity should not be mutually exclusive, as The Institute of Leisure and Amenity Management (1999) put it “[t]he social, economic and environmental benefits of public parks should work together.”

Lawton, *et al.* (2010) also point out that conflicts can include those between biodiversity and amenity “there will be some occasions where access needs to be controlled to avoid damaging or disturbing wildlife”, though they also suggest that access to nature (particularly in childhood) can benefit wildlife through raising awareness of its benefits and through affecting people’s attitudes towards it.

A case study of natural restoration of a park in Chicago (Gobster, 2001) found that stakeholders held four different visions of nature: nature as designed landscape, nature as habitat, nature as recreation and nature as pre-European settlement landscape. Gobster (2011) points out that it is necessary for those planning and maintaining parks to “integrate the different visions of nature expressed by the parks' stakeholders” so that the “cultural support” that is required to maintain the sites with their biodiversity and natural functions continues. He maintains that this is key in urban areas, where pressure from financial, political and other sources have previously resulted in the decline of parks.

Burgin (2016) asserts that the best way to incorporate biodiversity conservation into cities and their sustainable management is currently not well understood by the various stakeholders (for example urban planners to community activists). This means that bad decisions are sometimes made whereby flora and fauna are introduced, whether deliberately or accidentally, due to the current fashions in landscaping for example. These decisions can sometimes lead to long term issues for residents, workers, visitors and local authorities.

There are some pitfalls of reduced mowing, such as poor public perception. Sheridan (2016) highlights issues in terms of public opinion, when “cut badly or not cleared” it can lead to an increase in complaints. Sheridan asserts that “[a] large proportion of the population still see long grass as an ‘untidy mess’ especially in the winter, rather than an interesting habitat, food source or protective shelter for wildlife.” Long grass can also be seen as a fire hazard in dry conditions, a source of pollen allergens for hay fever sufferers and a trap for litter. The correct timing and type of cutting can help to alleviate these problems. The process of change needs to be managed well with the public informed and consulted, Sheridan (2016) states that “[o]ften mowing frequencies have been cut across the board without warning or discrimination, generating complaints from all stakeholders” and that it is rare that this has been “done in the strategic context of challenging the traditional role of open spaces and identifying clear roles for it in the 21st century.” Sheridan (2011) suggests that, to help persuade the public that changes in maintenance are not only for budgetary reasons or bad practice, one needs to “sweeten the pill” by using native wildflower planting and colourful naturalistic planting, and that "councils could/should be beacons of good practice." He states that "parks professionals should show the way forward, but they must make their case properly, tell the story well and manage the change effectively, if they hope to persuade a sceptical public." Preferences for mowing regimes are investigated here (Chapter 5).

In the author's experience, complaints about wilder areas sometimes relate to feelings of personal safety. It is therefore important to plan any management changes well, for example so that sight lines are maintained. Or as the Council of Europe Committee of Ministers to Member States on Urban Open Space (1986) put it "in the provision of new areas of space, it will be essential to achieve a sense of personal security as this can lead to a feeling of belonging and comfort for those who will use the area." Andrew Hinchley of the London Borough of Camden (cited in (House of Commons Communities and Local Government Committee, 2017)) stated that:

> *"The things that prevent people from going to use a space are particularly damaging - as much so as conflicts within space - and can often affect the more deprived communities much worse. They are particularly susceptible to changes in maintenance regimes, so if the quality of the space declines, people feel less secure, women and children are less likely to use it, and ethnic minorities are less likely to go and use that space."*

Therefore, it is imperative that any changes in maintenance do not make an area appear uncared for or unsafe. The scale and character of an area or city should be considered in open space provision. The Council of Europe Committee of Ministers to Member States on Urban Open Space (1986) even suggest that the retention or replacement of the surrounding buildings should be considered. If an open space is not appropriate for the area then the “lack of harmony” can lead to “visual conflict which is likely to make an area forbidding” (The Council of Europe Committee of Ministers to Member States on Urban Open Space, 1986). This should be considered when changing the management of open space. The Council of Europe Committee of Ministers to Member States on Urban Open Space point out that large bleak areas are likely to be expensive and underused. Closely mown grassland can appear bleak, a variety of mowing regimes and introduction of wildflowers could help to combat this, as could new tree plantings or using shrubs or hedges to break up an area, all of which could have positive impacts on biodversity. The Council of Europe Committee of Ministers to Member States on Urban Open Space (1986) also touch upon the importance of community engagement and education in greenspace. Partnerships and engagement can lead to a sense of ownership and respect for spaces which has a huge positive impact on their sustainability.

Under austerity, Nam and Dempsey (2019) suggest that, “the provision of abundant features in parks including extensive bedding plant display is a superseded practice” with a move to lower maintenance “naturalistic plantings”. They found that acceptance of these changes varied, depending on the characteristics of the respondent. This study further investigates people’s preferences for planting types. In her doctoral thesis Hoyle (2015) suggests that the next challenge would be assessing biodiversity in relation to perceived attractiveness for the planting styles in her studies. Natural spaces can be better for people. For example, Houlden *et al.* (2019) found that the amount of natural greenspace had a statistically significant positive relationship with hedonic wellbeing while the amount of other types of greenspace did not. The current study aims to tackle both the biodiversity and attractiveness to human visitors of various greenspace management regimes.

2.7 The dearth of data on greenspaces

"Reliable and up to date information on public parks can be difficult to access and is notoriously fragmented"

Heritage Lottery Fund (2014) *State of UK Public Parks*

As stated previously, urban ecology is understudied, with only 3% of ecological studies focussing on urban areas (Corbyn, 2010). There is also a more general lack of data about parks in the UK at the national level. For example Guy Newey, Head of Environment at The Policy Exchange (cited in Appleby, 2014) states that greenspace data is "poor", citing the example of local authorities applying a nominal value of £1 to their sites, so the true value of these resources is unknown, this does not facilitate a good understanding of the resource, nor does it support effective campaigning for greenspace.

This lack of data has long been acknowledged. For example, The Environment Transport and Regional Affairs Committee (1999) suggested that more research and better record keeping was required in relation to the quantity of parks and greenspaces, and whether they were increasing or decreasing in number and/or size. It also suggests a need for data about the costs associated with greenspace maintenance, and whether there are effective low cost maintenance methods. The committee also recommended that government lay out or implement a research programme to this end and that local authorities keep and share records of their sites and facilities, and of visitor numbers.

However, this gap in data was not filled. Before closing in 2011 due to funding cuts, the open space section of the Commission for Architecture and the Built Environment (CABE Space) carried out a range of research and advocacy relating to greenspace. They pointed out that there are huge gaps in the data available regarding the UK's parks and open spaces, and that what does exist is "patchy and inconsistent" (CABE Space, 2009). There was no single resource that documents how many greenspaces there are, the area of land that they cover, the quality of the green spaces, who owns them nor who manages them. Some data is available, though it is often scattered across disparate locations (e.g. at various local authorities), or held by particular bodies, for example local authorities or other government bodies, and on databases specific to certain categories of greenspace such as sports grounds. Until the recent production of a national Greenspace map by Ordnance Survey (2017) there was no centralised database. Therefore national policies relating to parks and greenspace were not based on a complete understanding of the resource. The Ordnance Survey's map is not currently a comprehensive measure of UK greenspace. For example, in Coventry a fairly large park, Lake View, is missing from the open greenspace map and Holbrooks Park, classified as an 'area park' by Coventry City Council (2008), second in its "hierarchy of provision", is shown as a 'playing field' in spite of providing a range of facilities including footpaths, a play area and a skate park. Most of the smaller and incidental open spaces and river corridor greenspaces in Coventry are not included on the map. These examples are chosen due to the author's familiarity with Coventry and its greenspaces. The pattern is likely to be similar for other cities. There is also a lack of detail in the categorisation of the sites on this map, as is described in Chapter 4.

In another of CABE Space's publications (CABE Space, 2010), they stated that "the lack of co-ordination in regard to data collection is one factor limiting present understanding of the urban environment." Heritage Lottery Fund (HLF) head of landscape Drew Bennellick (cited in Cosgrove, 2014) indicated that, when working on *The State of UK Public Parks* report for the HLF, "[o]ne of the things that really frustrated us was getting hold of data, there was a total lack of it." He goes on to lament the loss of much of the good data that CABE

Space generated. HLF found it necessary to commission their own research due to the lack of existing data available to them.

As stated in Section 2.2 above, PPG17 (Department for Communities and Local Government, 2002) required local authorities to audit their greenspace provision. The guidance was replaced by the National Planning Policy Framework in 2012. At the start of 2010, 62% of local authorities had adopted a greenspace strategy, but only 41% of these were based on PPG17 (Commission for Architecture and the Built Environment, 2010). Therefore, it is unclear whether those not based on PPG17 had carried out a similar audit. Data was not collected at the national level from these greenspace audits and, as PPG17 has now been superseded, it seems that this was a missed opportunity to create a comprehensive national dataset on greenspace.

New types of data including “big data”, such as mobile phone data, are starting to be used in research into parks and greenspace. For example, Caceres *et al.* (2012) studied activity levels around New York’s Central Park using mobile phone data, and concerns were raised about privacy in the UK’s *Guardian* newspaper about the use of EE Network data to count users of Hyde Park in London (Williams, 2015). Social media are also beginning to be used, in particular to measure people’s sentiments in relation to greenspaces (e.g. Brindley *et al.*, 2019; Roberts, Sadler and Chapman, 2019; Schwartz *et al.*, 2019). These new data sources may yield some useful information relating to parks, but they should be used with caution and an understanding of how they are created and, as not everyone uses any particular social media platform, they should not be assumed to provide a representative sample of the population.

There is a gap in both ecological data and data on human preferences in greenspaces, and a lack of data to support the management decisions of greenspace managers. This study aims to contribute to the reduction of this gap through better understanding of the impacts of management changes on people and pollinators.

Below, section 2.8 helps to identify the datasets which were available for this study. The case studies utilise some of the data acquired which were not used in the main studies.

2.8 Exploratory case studies

As stated in the Literature Review (section 2.7), there is a lack of data related to parks and greenspaces. For example, there was no national map or database of greenspaces until the release of the Ordnance Survey (2017) Greenspace Map, which is currently not comprehensive (as described in Chapter 4). Other data are held by a range of local and national organisations and are often not open data and are therefore not available for free or without specific, restrictive use agreements.

In the initial stages of developing this research, a variety of open data sets were investigated as a means to conduct analyses on biodiversity and human preferences in greenspaces. Where open data were not available, direct contact was made with organisations who were likely to hold data to request sharing of the data. Table 1 outlines the range of datasets that were acquired. Data for both pollinators' preferences and people's preferences for specific greenspace management types were not available, which led to the decision to conduct field work and a questionnaire.

Four of the potential studies which were investigated in the early stages of this study are outlined below as case studies/summaries. These did not contain enough data for a full analysis and the reasons are outlined in each of the four sections.

Table 1: Datasets acquired or created for this study.

Dataset	**Open?**	**Data holder**	**Description**	**Reason if not used**
OS Greenspace	Y/N (less comprehensive open version)	Ordnance Survey	Map of UK's greenspaces	
London Greenspace	No	Greenspace Information for Greater London	Map of London's greenspaces	
Scotland Greenspace	No	Greenspace Scotland	Map of Scotland's greenspaces	
Scenic or Not	Yes	Data Science Lab, University of Warwick	Crowdsourced scores of scenicness of geotagged images	
Green Flag Awards	No	Green Flag Awards	Scores from national standard for greenspaces	
Sheffield Urban Nature Project	No	Sheffield City Council	Ecological surveys of sites where management has changed	Format. Control site not re-surveyed
Sheffield complaints	No	Sheffield City Council	Public complaints, compliments and comments for greenspaces	
Coventry grounds maintenance	No	Coventry City Council	Grounds maintenance of greenspaces	Was to be used with HBA data (below)

Habitat Biodiversity Audit (HBA)	No	Habitat Biodiversity Audit	Phase 1 habitat survey results.	Not enough sites re-surveyed in period of interest
Coventry complaints	No	Coventry City Council	Public complaints, compliments and comments for greenspaces	
Beewalk	No	Bumblebee conservation	Citizen science transect survey of bumblebees	
Flower-Insect Timed Count	No	Centre for Ecology and Hydrology	Citizen science quadrat survey of pollinators	Data not available at time of writing. Most counts in private gardens
Parks preference survey	No	Author	Online survey on people's preferences in greenspaces.	
Parks pollinator survey	No	Author	Survey of pollinators and habitats in West Midlands parks.	

2.8.1 Green Flag Award data

The Green Flag Award (2016) is the national standard for parks and greenspaces in the UK. Sites are assessed by trained judges, who have experience and expertise in the greenspace sector, and scored against a range of criteria from environmental management to community engagement, based on the site's management plan as well as a judging visit in person. In recent years, instead of an annual full judging visit, sites receive a 'mystery shop' visit on alternate years.

It was hypothesised here that, due to lower intensity management, cost savings could be having a positive impact on biodiversity by allowing areas to become wilder whilst having a negative impact on traditional 'neat' horticultural standards, and that this relationship could be measured in the scores attained at Green Flag Award judging.

For the purposes of this study Green Flag Awards were able to share their data for 2009 and 2013 to 2016. They provided the desk-based, (management plan) score, the total field visit score, as well as the overall score. They also provided a score out of 10 for the two field visit judging criteria that were of particular interest here: "Conservation of Natural Features: wild flora and fauna" and "Grounds Maintenance and Horticulture". There were a total of 1790 parks and greenspaces included in the full dataset. These data were analysed below to test the relationship between conservation and horticulture.

Overall, there was a slight upward trend in the complete dataset for both criteria (Figure 1). In an exploratory analysis using linear models, there was a small increase in both horticulture and conservation scores with year (correlation coefficient estimate 0.05 in both cases, at p=<0.001, the mean increase in score per year was 0.05).

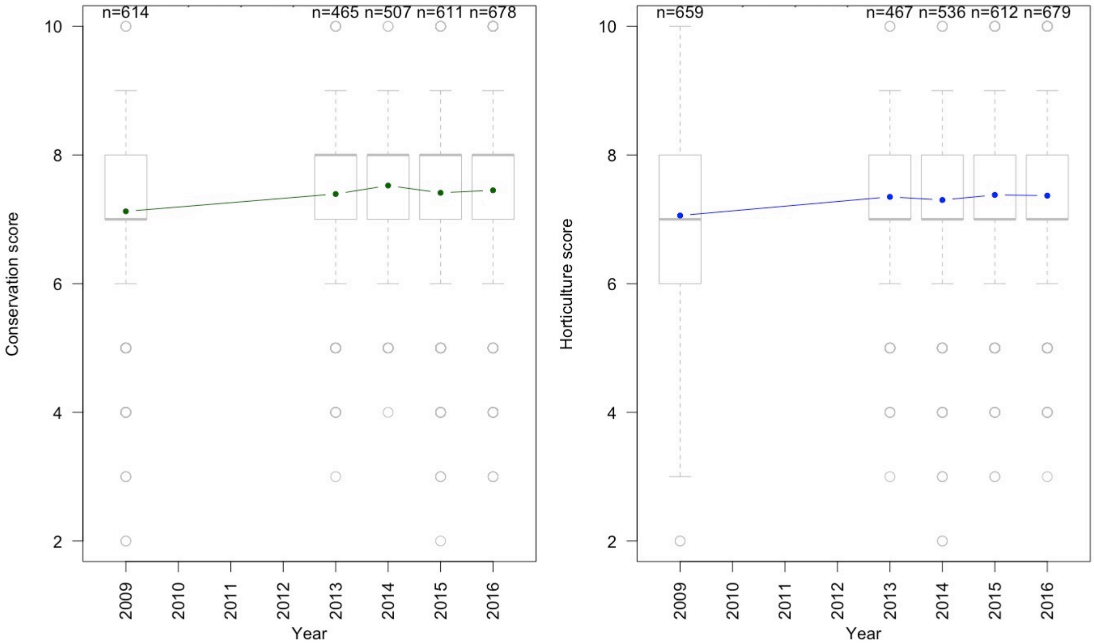


Figure 1: Green Flag Award mean judging scores the specific field visit criteria "Conservation of Natural Features: wild flora and fauna" and "Grounds Maintenance and Horticulture". Boxplots shown behind to indicate distribution of data, thicker line across each box is the median, and the upper and lower edges of the box are the quartiles.

There was also a slight upward trend in the overall mean scores (Figure 2). The upward trend in all scores could be expected as many sites are ongoing award participants and, therefore, they are working to improve their standards. A slight downturn in the last 2 years in the desk score may be caused by park managers, who are under pressure due to austerity and may not have sufficient time to update their management plans. However, the effect was small, and may just be caused by the standard of entrants in that year. Linear regressions, which model the change in a dependent variable in relation to the change in independent variables, were carried out for each score against year confirm the trends (desk: coefficient estimate 0.16, field: coefficient estimate 0.38, both p=<0.001).

Individual linear models for each year showed a positive correlation between the horticulture score and the conservation score, this was significant at *p*=<0.001 in all cases, the correlation coefficients were between 0.33 and 0.52.

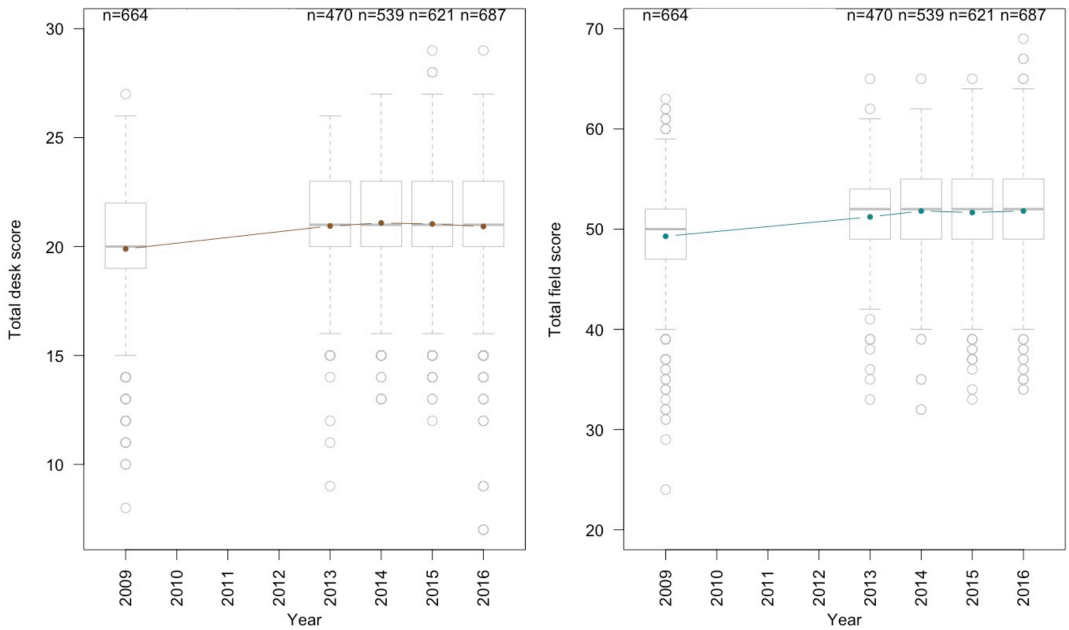


Figure 2. Green Flag Award desk and total scores. Boxplots shown behind to indicate distribution of data, thicker line across each box is the median, and the upper and lower edges of the box are the quartiles.

2.8.1.1 Paired years

Due to the two year cycle of judging described above, and because some sites had not been given a score for one or other of the criteria, the data contained many missing values (*NA*s). Therefore, it was not possible to compare the scores of an individual site across all years, so paired datasets with no NAs were created with 2013/2015 and 2014/2016 data. 2009 data were not used in this analysis as 2011 data were not provided, so there were no data to pair them with. The 2013/2015 dataset contains records from 349 parks and greenspaces, the 2014/2016 dataset contains 374 records. The relationship between conservation and horticulture was positive in all years (Figure 3 and Figure 4). This was supported by the results of linear regressions (correlation coefficients between 0.27 and 0.37, all *p*=< 0.001).

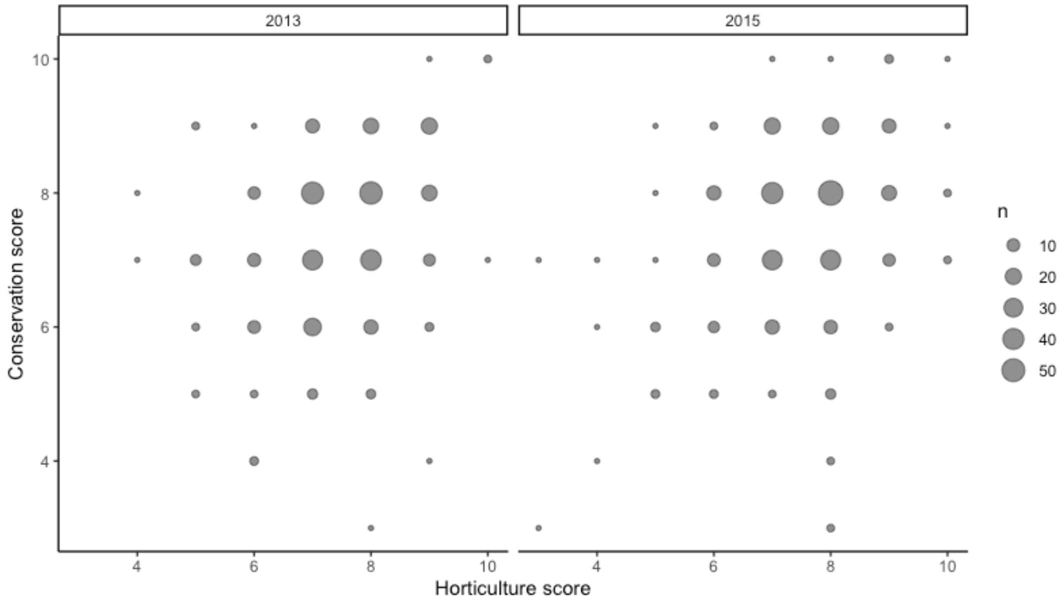


Figure 3: Shows the positive relationship between Green Flag Award field judging: conservation score and horticulture score 2013/15 paired data. The size of the points corresponds to the number of observations at each location on the graph.

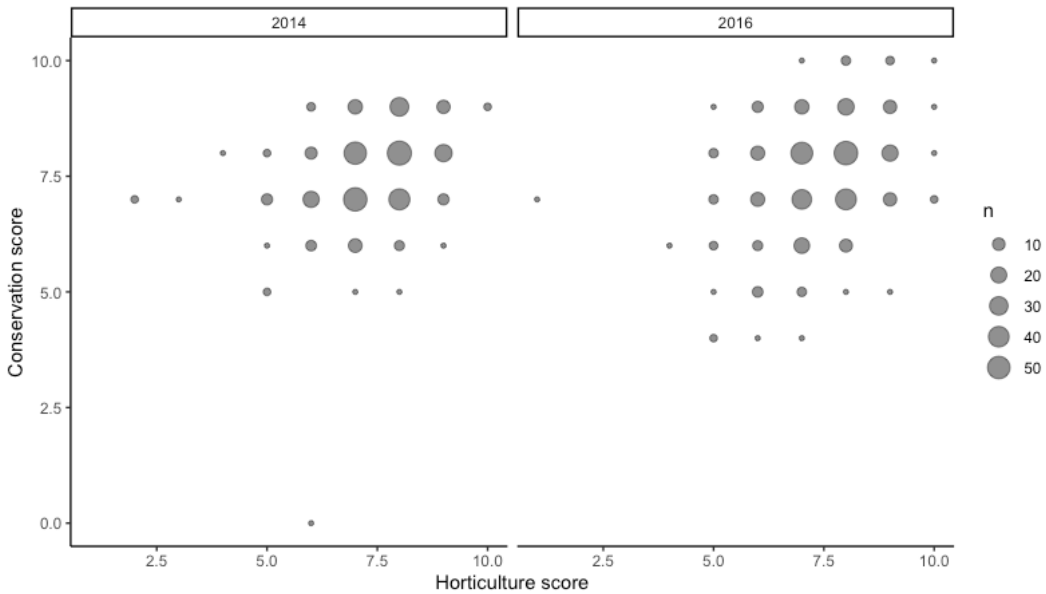


Figure 4: Shows the positive relationship between Green Flag Award field judging: conservation score and horticulture score in the 2014/16 paired data. The size of the points corresponds to the number of observations at each location on the graph.

Linear regressions for each criterion in each set of paired years showed a slight upward trend (correlation coefficients 0.18 to 0.43, all *p*=<0.001), so sites tended to score slightly, but statistically significantly, higher when revisited. However paired plots (Figure 5 and Figure 6) show a mixed picture with many sites' scores falling as well as many rising.

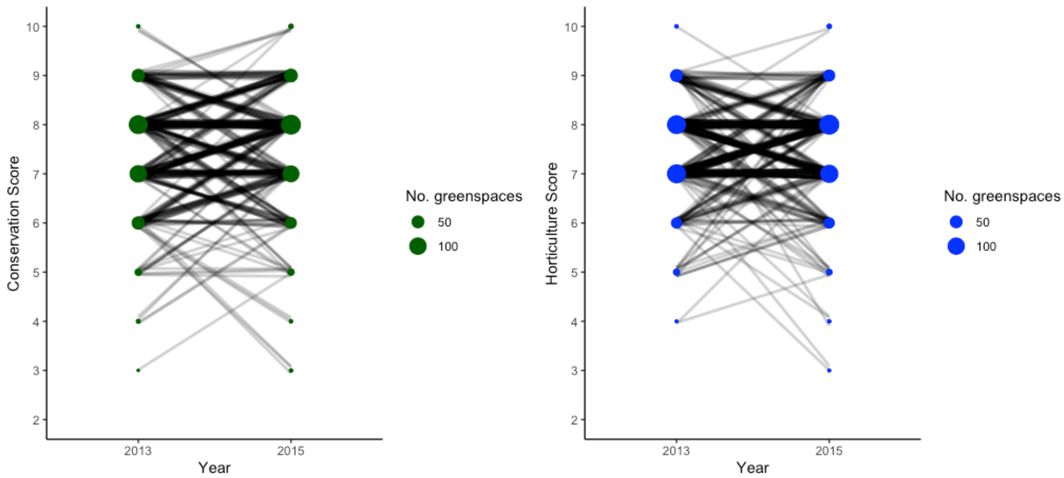


Figure 5: Paired plots for two Green Flag Award criteria in 2013 and 2015. Scores for some parks increased and others decreased.

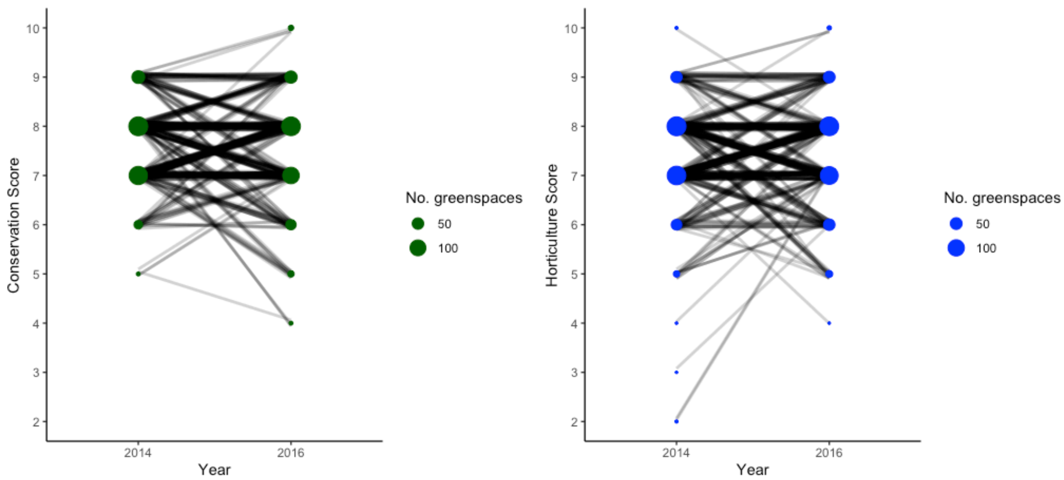


Figure 6: Paired plots for two Green Flag Award criteria in 2014 and 2016. Scores for some parks increased and others decreased.

Contrary to the hypothesis that as conservation scores rise, horticultural scores may drop, the relationship between Green Flag Award horticulture scores and conservation scores was positive. Parks which were managed well for biodiversity were also managed well by more traditional standards. There was an upward over time in all scores, suggesting that Green Flag Award holding parks are improving standards.

Green Flag data is not open data and had to be requested with an agreement made, including maintaining anonymity of the greenspace owners. The dataset contained a large sample of greenspaces (N=1790) which allows for robust analyses. Scores are given by experienced professionals in the field of greenspace management, who are trained in the Green Flag standards, so they are reliable. The whole of the UK is covered by this dataset so local variation in the data is not only due to local management. The data contained general information from which management could be inferred to a degree, for example horticultural and conservation scores, but not more detailed information on the specific management styles, such as types of flower bed. The parks that are selected to be put forward for a Green Flag are likely to be the managing bodies' flagship sites and may receive extra maintenance in preparation for a judging visit, so the scores may vary in other sites managed by the same body.

The above pilot study is a novel use of the Green Flag Award data, showing that the relationship between horticulture and conservation in the judged greenspaces was positive. This was contrary to the expectation that horticulture scores may fall as conservation scores rise. This demonstrates that there can be a positive relationship between management for wildlife and management for aesthetic reasons.

2.8.2 Coventry parks data

Coventry City Council made a range of greenspace management and maintenance changes in 2013. Notably, reducing the frequency of grass mowing in most places and changing some regularly replanted seasonal flower beds to perennial bedding (Andy Beechey, Coventry City Council, pers. comm. 2016). Coventry City Council's Parks Service provided their grounds maintenance data for 2013 and 2017, before and after their management changed. See sample in Figure 7.

Phase 1 habitat data for the whole of Coventry, from 2013 to 2017, were provided by Warwickshire Habitat Biodiversity Audit (HBA). The HBA carry out Phase 1 surveys (Joint Nature Conservation Committee and JNCC, 2010), a walk-over survey used to categorise areas into standardised habitat types, covering the whole of Warwickshire, Coventry and Solihull on a rolling programme (Habitat Biodiversity Audit, 2017). See sample in Figure 8.

It was hoped that the two datasets could be compared to show the effects of management changes on habitats, but few sites in Coventry were resurveyed during the period of interest: only one neighbourhood park and some smaller areas of greenspace.

These data were not open data and had to be requested with agreements from the data owners. The two datasets are highly detailed, containing information down to the specific management of a particular flower bed in the case of the council's data or to the classification of a block of habitat within a site in the case of the HBA's data. This level of detail has a lot of potential to allow the examination of the effects of management at the local level, when the HBA have resurveyed a greater proportion of the sites within Coventry since the management changes. The HBA data are collected by ecologists and trained volunteers so they are likely to be accurate. Coventry City Council’s data are maintained by park managers who are very familiar with the sites so they are also likely to be reliable. The data only include one small city and the relationship may differ elsewhere. Other areas of the UK do not generally have full Phase 1 survey coverage as Warwickshire and Coventry do (Chris Talbot, HBA, pers. comm., 2017). It would be interesting to compare other areas where Phase 1 surveys have been carried out. This would necessitate individual agreements with the owner of the Phase 1 data and with local authorities to release their management data, which could be demanding and challenging to acquire. In the case of Coventry data sharing was facilitated by the author’s contacts from previous employment.

Figure 7: Map showing grounds maintenance in the War Memorial Park, Coventry. Map created in QGIS

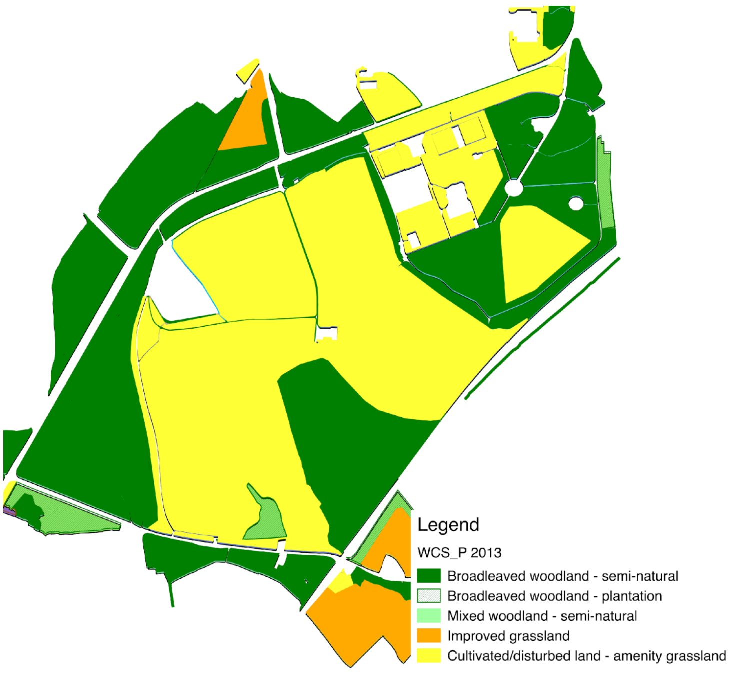


Figure 8: Map showing Phase 1 habitats in the War Memorial Park, Coventry. Map created in QGIS

2.8.3 Coventry Complaints, Comments and Compliments

Data were acquired from Coventry City Council's contact centre for comments, complaints and compliments, to assess the effect of greenspace management changes since 2013 in Coventry on residents' satisfaction (Figure 9). Coventry City Council were unable to provide baseline data from 2012, nor could they provide any detail such as the location of the greenspace nor the nature of the enquiries. Changes in the number of comments and compliments were not statistically significant between 2013 and 2017. There does appear to be an upward trend in complaints, though a linear model of complaints by year produced a coefficient estimate of 7.3, but this was only significant at p =< 0.05. All of the numbers were small and, without more detail on the nature of the enquiries, it is difficult to infer anything further from this.

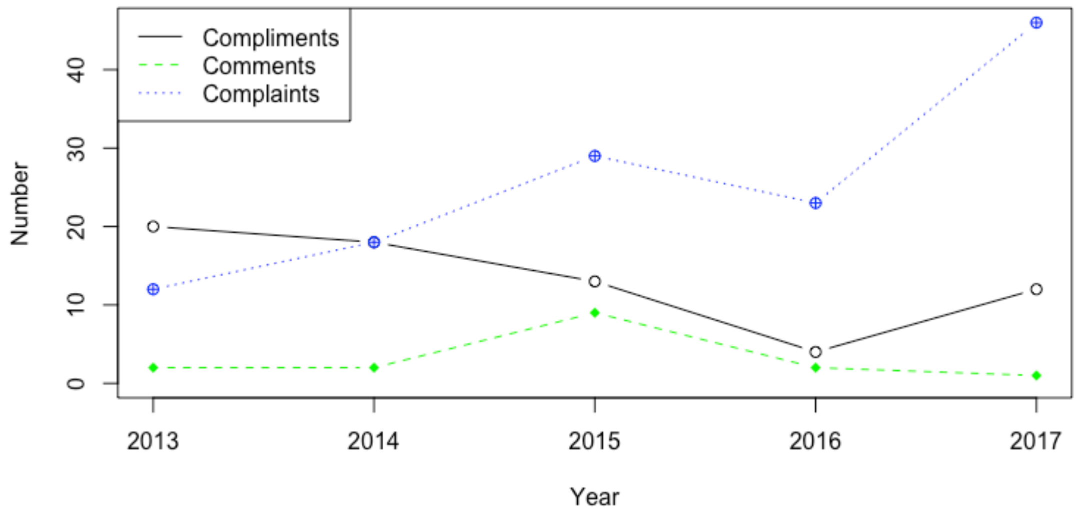


Figure 9: Coventry City Council Comments, Compliment and Complaints for Parks and Greenspaces (no data for 2012 before changes were implemented).

These data were collected by Coventry City Council's 'contact centre' who deal with phone calls, letters and e-mails to the councils main addresses. These are logged by council staff. Informal contact to individual service areas were not included here. The number of enquiries received by the council was small, which contributes to the lack of statistical significance. There were also no data available from before the council changed parks management meaning that the current level of enquiries could not be compared to those received before the management changes were implemented.

2.8.4 Sheffield Urban Nature Project

Species count data, including plants, birds and butterflies, were provided by Sheffield Ecology Unit for three sites included in Sheffield Urban Nature Project. As part of this project, two of the three sites (Common Lane and Waterthorpe Park) have undergone management changes since 2013, including reduced mowing. The management of the third site (Herdings Park) is unchanged so that it can act as a control. At the time of writing, the control site had not been resurveyed so it was not possible to use this as a comparison. As species numbers experience natural fluctuations, it was not possible to establish a trend for the other two sites over such a short space of time, with limited data, and without a control. The data were also in a range of formats, including scans of hand written field notes so pre-processing the data was time consuming. This was not open data and access involved visiting the ecology unit to copy the files.

Logs of public complaints and comments were also provided by the Parks Service, for the same three sites included in Sheffield Urban Nature Project. Records relating to anti-social behaviour were removed as there was not a clear link to the management changes. The remaining records, all related to maintenance are shown in Figure 10.

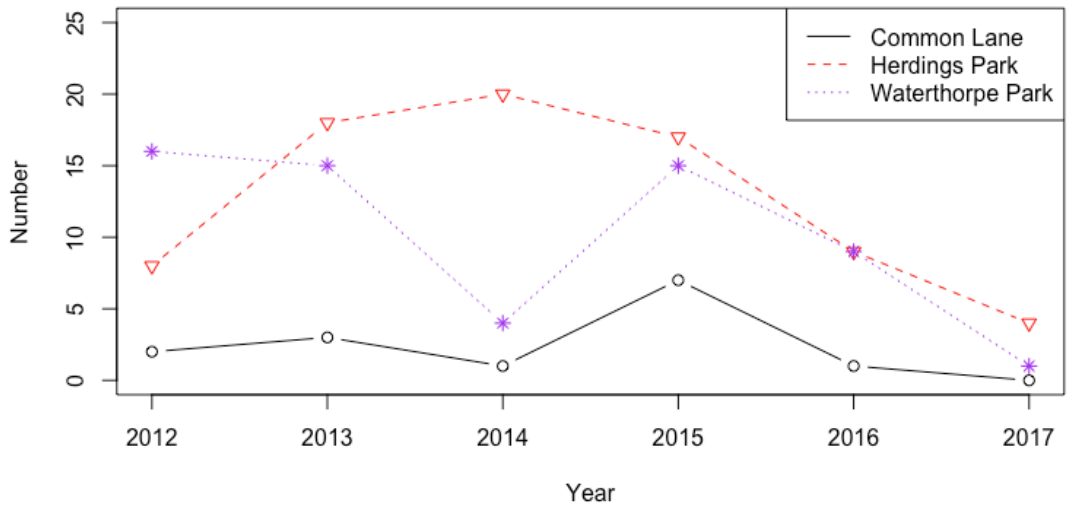


Figure 10: Complaints and Comments for Sheffield Urban Nature Project. Note: to November 2017. Herdings Park is the control site with no management changes.

The two sites where management has changed appear to have a fall in complaints after the changes between 2013 and 2014 before increasing again in 2015, while the control site has a slight increase, followed by a drop. This suggests that people did not have an immediate negative response to the management changes. The numbers were small and it was not possible to demonstrate statistical significance.

According to a parks professional and an academic (cited in Nam and Dempsey, 2019) the project didn't save the as much money as Sheffield City Council had hoped. Nam and Dempsey (2019) further state that the project "has resulted in lower levels of public acceptability of naturalistic plantings in particular LGP [long grass plantings]".

2.8.5 Exploratory case studies summary

The above case studies demonstrate that data relating to parks and greenspaces are limited, held by a range of organisations and they are often challenging and time consuming to acquire and to process. A range of formats also makes it challenging to compare data from different organisations. Some useful data were acquired and used in the following chapters, but the lack of data in general created an opportunity for some primary data collection.

2.9 Literature and Data Summary

"*Parks and greenspaces have many functions. They provide amenity, recreation and places to play. They benefit our physical and mental wellbeing. They generate clean air and can store greenhouse gasses. Many of us go to parks to experience nature. Parks can also benefit biodiversity by providing places for plants and animals to live, feed and reproduce.*"

Edinburgh Biodiversity Partnership (2017)

The importance of parks and other greenspaces is well documented, but this has not prevented them from experiencing a repeating cycle of renewal and decline. The current government austerity measures are impacting parks to a greater degree than many other public services.

In the above literature review, 'greenspace' was defined for the purposes of this study as publicly accessible urban green areas, and parks are a more formal subset of this. 'Amenity' was defined as the usefulness of these spaces for recreation, though other types of amenity should also be considered, for example "visual amenity".

Biodiversity is a key ecosystem service which underpins a range of other services. There are opportunities to enhance biodiversity, and the ecosystem services it supports, through changing management and maintenance in urban parks and greenspaces, some changes can also provide budget savings, but changes should be carefully planned and introduced to ensure that public enjoyment of the spaces is not reduced. Changes are occuring already, though the impact of these changes is not well understood. This impact is investigated in this study.

There is potential for conflict between the various roles that greenspaces play for urban areas. There are also opportunities to find ways to promote multiple benefits without the loss of others. For example, increasing biodiversity and public enjoyment together, which is the focus of this research.

There is currently a lack of data relating to urban parks and greenspaces. Various datasets from a range of organisations were investigated in the writing of this thesis. The data that exist are curated by various orgnisations and much of the data is challenging to access. Urban biodiversity, a key aspect of greenspace, is also understudied. Studies which integrate the data on parks and biodiversity, and also take into account human preferences and landscape management are scarce. This study aimed to contribute to filling this gap by investigating urban biodiversity and ecosystem services alongside human preference.

3 GREENSPACE MANAGEMENT PRACTICES AND POLLINATION

3.1 Introduction

This study investigates the effect of greenspace management, on the provision of ecosystem services, i.e. the benefits to humans arising from ecological functions and processes. The research was undertaken through investigations of the abundance and species richness of pollinators in different management regimes in urban greenspaces in the West Midlands. Human preferences for the same types of greenspace management are investigated in the following chapters to allow comparison of the effects of greenspace management changes on people and wildlife.

A preliminary study of pollinators in a range of habitats was undertaken in Coventry in 2017. This led to a more focused study in 2018 which concentrated on two types of floral display, seasonal and perennial flower beds. A total of seven sites were surveyed, in Coventry, Rugby, Warwick and Leamington Spa. Each of these sites contained both seasonal and perennial flower displays, providing a sample set of 72 paired quadrats. The results from the 2017 study were then compared with national data sets from the Bumblebee Conservation Trust (Comont and Dickinson, 2017). Data from 2017 were used as the methods were similar (using transects). The Centre for Ecology and Hydrology (Carvell and Roy, 2019) data were compared to the 2018 quadrat counts in the current study, but only headline data were available at the time of writing.

A number of studies have documented a worldwide decline in the abundance and diversity of insects (e.g. Biesmeijer *et al.*, 2006; Hallmann *et al.*, 2017;

Powney *et al.*, 2019; Goulson, 2019; Sánchez-Bayo and Wyckhuys, 2019). This is of concern as insects have important roles in ecosystems, from providing food for larger animals to pollination of wildflowers and crops (Samways, 2005). In the urban setting these insects provide pollination services in gardens, greenspaces and allotments as well as neighbouring farmland and they provide food to wildlife such as birds. People also derive enjoyment from seeing pollinators, for example watching butterflies, and so pollinators also contribute to cultural ecosystem services (McGinlay et al., 2018).

Pollinating insects were chosen for this study as they provide both an example of a key ecosystem service and an indicator of ecosystem function. Pollinators, particularly bees and butterflies, are commonly used as environmental indicators as their short life cycles and sensitivity to change mean that they respond quickly to habitat alteration (Goulson and Nicholls, 2016; Mauricio da Rocha et al., 2010; Brereton et al., 2011). Urban parks and greenspaces contain a range of habitats and features which may support pollinators, such as floral displays and flowering trees and shrubs. When pollinating insects are numerous and diverse within a habitat it is a strong indication that the ecosystem is functioning well and that it can provide pollination services reliably (Haase et al., 2014; Andersson,Barthel and Ahrné, 2007).

Had long-term data sets been available for pollinators in relation to specific habitats and management in parks this would have allowed the measurement of trends in pollinator numbers in relation to greenspace management changes over time. However, these changes take place over longer timescales than a full-time PhD permits. Existing data were sought that might help to answer questions about the effects of greenspace management changes on the delivery of ecosystem services. Ecosystem services in relation to park management are currently understudied. As stated in the Exploratory

Case Studies section (section 2.8), no openly-available data were found that would address this question and so the research necessitated primary data collection.

Birds are another group commonly used as an indicator of environmental quality or change, and that might have potential to demonstrate the effect of greenspace management changes. Birds contribute ecosystem services, for example seed dispersal, consumption of crop pest species and enjoyment by those who observe them (Whelan,Şekercioğlu and Wenny, 2015). They have a range of characteristics which make them useful as indicators. For example, they are relatively easy to detect and are sensitive to habitat change (Chambers, 2008). As outlined in the Exploratory Case Studies section, data on butterflies and birds from Sheffield's Urban Nature Project, had potential for use in this project but it had limitations because of a lack of repeat visits to the control site, limited data for the other 3 sites in this project, and multiple data formats. The decision was therefore made not to use the data from Sheffield. Another potential longer term dataset was the author's data collected data on breeding bird diversity and abundance in Coventry parks during previous employment. The bird counts were continued into 2017, but this data set was found to be too sparse to identify any trends in bird diversity and numbers over time.

Pollinators were chosen for this study as a sensitive and relatively conspicuous indicator of ecosystem function, and also a provider of an ecosystem service. They are relatively common and easily observed in urban environments and they rely upon habitat features of interest in urban greenspace management, such as floral resources.

3.2 Background

Local authorities throughout the UK have been affected by recent government austerity measures, resulting in parks services trying various changes in their management approaches to reduce costs. For example, in the West Midlands, as part of a cost cutting exercise in 2016, Coventry City Council increased the interval between grass mowing operations from 10 to 20-days in most of the areas that it manages, alongside changes from seasonal flower bedding to perennial bedding. In recent years, the council have also created many new areas of 'Pictorial Meadow' plantings (Pictorial Meadows, 2017) in a range of park and highway locations. Pictorial Meadows are grown from a proprietary seed mix that includes both native and non-native wildflowers. These plantings reduce the area requiring regular mowing (Andy Beechey, Coventry City Council, pers. comm. 2016) and so could reduce management costs. Rugby Borough Council have also relaxed their mowing regimes in some areas, changed the type of bedding in some beds, and introduced areas of Pictorial Meadows on road verges (Colin Horton, Rugby Borough Council, pers.comm. 2018). Warwick District Council covers the towns of Warwick and Leamington Spa, both of which were used in this study. Over the past 10 years Warwick District Council has "drastically reduced" seasonal bedding, replacing it with perennial bedding, and have also incorporated areas of longer grass (Simon Richardson, Warwick District Council, pers. comm. 2018).

Seasonal/traditional floral bedding is costly in terms of both labour and materials because it is replanted at least two times per year with new plants, usually 'summer' and 'winter' bedding. The plants are often bought in from commercial nurseries. Some local authorities maintain their own nurseries but this is becoming uncommon, due to the costs involved. In contrast, perennial bedding is planted once and the ongoing costs are incurred through maintenance, for example through pruning and replacing any lost plants.

Perennial bedding is generally cheaper as there is not regular expenditure on plants and, as it is not regularly replanted, it is less labour intensive.

Seasonal bedding can include perennial plants, which are capable of living and flowering for several years, such as zonal geraniums (*Pelargonium* spp.), though in some cases these are not frost-hardy. Perennial bedding can include annual plants, which grow from seed each year. In this study the terms 'seasonal bedding' and 'perennial bedding' are used to differentiate between the methods of cultivation. As the original management approaches of seasonal bedding are still being used in some areas of the study sites it was possible to develop a comparison of the alternative forms of management. Figure 11 shows examples of each type of flower bed.

Figure 11: Examples of seasonal bedding in War Memorial Park, Coventry (left) and perennial bedding in Longford Park, Coventry (right). Photographs taken by the author.

3.3 Study Question /Aim

The question this study addressed is:

- Which type of floral planting (seasonal or perennial), in the West Midlands' parks, attracts the greatest abundance of pollinators and pollinator species richness?

3.4 Objectives

This study contributes to the following objectives outlined in the thesis introduction:

RO1. Identify changes in management practices in urban parks.
RO2. Investigate effects of management practices, in particular floral planting, on pollinator abundance and species richness.

The study investigated whether seasonal bedding or perennial bedding attracts a greater number or richness of insect numbers pollinators. Seasonal bedding may provide a longer flowering period as it is regularly replanted, but do the flowers in seasonal bedding schemes differ in their attractiveness to pollinators when compared to those in perennial bedding?

3.5 Literature Review

3.5.1 Related Work

Data and understanding on the status of pollinators in the UK is limited (Department for Environment Food & Rural Affairs, 2014). There is also a lack of evidence on the best management practices in urban areas to promote their conservation (Baldock *et al.*, 2015a). This literature review outlines existing work on pollinator abundance and diversity in a range of habitats.

There are a number of studies which investigate pollinator numbers in different habitats. For example, Baldock *et al.* (2015b) compared pollinator abundance and species richness in three landscapes: urban, farmland and nature reserves. They found that “flower-visitor abundance and species richness did not differ significantly between the three landscape types” but bee species richness was lower in farmland than urban areas. Guenat *et al.* (2018) found that urbanisation did not have an effect on bee diversity or abundance, but that it had a negative impact on the abundance of beetles and wasps. Taking into account management practices, bee abundance did not decrease with increasing urbanisation on informal greenspace or amenity space, but it did on farmland. With urbanisation effects accounted for, farming was associated with fewer bees and amenity land with fewer beetles. These studies suggest that urban environments are important for bees and that further investigation of the drivers for pollinator diversity and abundance in cities is warranted.

A key question for parks management is ‘which habitats in public open spaces support pollinators?’ This question was partially investigated in a study of public gardens in Paris, which found that pollinator “richness” was not associated with the total area of flowerbeds included in small public gardens (Shwartz et al., 2013). The authors suggested that encouraging gardeners to “design pollinator-friendly flowerbeds, could help in further enhancing pollinator's diversity in small public gardens" (Shwartz et al., 2013). This raises the questions, why is pollinator richness not associated with the area of flower beds in Shwartz *et al.*'s (2013) study, and what types of flower beds are attractive to pollinators? Tommasi, *et al.* (2004) found that "traditionally managed urban landscapes", for example seasonal flower bedding and gardens, had lower bee abundance and diversity than "ecosystem-oriented urban landscapes such as "Naturescape parks", undisturbed lots, and community gardens."

Some studies have compared pollinators in different urban habitats. In Australia, Threlfall *et al*. (2015) found greater bee abundance and richness in public parks when compared to golf courses and streetscapes/front gardens. Another study from Australia (Makinson, Threlfall & Latty, 2017), in community gardens (used for growing food), did not find a significant relationship between pollinator numbers, bee species richness, abundance or diversity and any of their list of environmental variables, including distance to forest and the area of flowers available. In Canada, Normandin *et al.* (2017) compared insect species in parks, community gardens and cemeteries. Normandin *et al.* did not find any difference in species groups between the habitats and "in general, the species assemblages did not show a specific association with habitats".

Garbuzov and Ratnieks (2014) compared insect preferences for a range of flowers in experimental beds on the University of Sussex, UK campus and found that pollinators had preferences for certain species of flower. The flowers in Garbuzov and Ratnieks' study were mostly typical of perennial bedding (lavenders, Lambs' Ear etc.). As the study did not include plants typical of seasonal bedding, it is not possible to use these results to suggest the likely effect of changing seasonal to perennial bedding in parks. Another study by the same authors (Garbuzov and Ratnieks, 2015) investigated pollinators' preferences within the national collection of asters, which provides a specific insight into a particular group of flowering plants but it is not transferable to bedding types with multiple flower varieties in parks.

Similarly, Rollings (2019) recorded bee visits to flowers over five years in a rural plant nursery that focuses on growing plants for bees. The main focus of this study was on perennials, but some annual flowers, commonly sold in six packs in garden centres, were also trialled and it was found that they were of little interest to pollinators. Rollings also found that seed-sown annuals, including those labelled as good for pollinators, or with the Royal Horticultural Society's "Plants for Pollinators" logo, tended to be visited by fewer pollinators than perennials and biennials. This suggests that plants that park managers may expect to be well-used by pollinators may in fact not be and that further research is required. Rollings' findings suggest that perennial plants may be more attractive to pollinators, but different treatments, were not compared specifically, for example seasonal versus perennial bedding. In greenspaces, some perennial plants are included in seasonal planting and some annual plants in perennial beds. The above studies focussed on trial beds.

Gunnarsson and Federsel's (2014) study was carried out in the field and compared pollinator counts in 13 urban gardens to counts in 13 flowerbeds in parks and green spaces in Gothenburg Sweden. They found that "Species richness was significantly higher in gardens than in flowerbeds, but diversity … was higher in flowerbeds than in urban gardens." Species richness is the number of species in a habitat, diversity also takes into account the evenness of the distribution of numbers between the species. Abundance in gardens was almost double when compared to flowerbeds. This may have been due to the mosaic of different habitats present in urban gardens and the relative 'monoculture' of seasonal flowerbeds, though the authors did not investigate different types of flowerbed.

In Surrey, UK, Salisbury *et al.* (2015) investigated the attractiveness to pollinators of native versus non-native garden flowers by planting trial plots with assemblages of 14 plant species in each of three 'treatment' types based on their geographical origin: 'native', 'near-native' and 'exotic'. They found that native and near-native treatments supported the greatest pollinator abundance, but suggested that the inclusion of exotics could extend the flowering season. Exotic and ornamental varieties of flower are often less attractive to pollinators, for example Corbet *et al.* (2001) found that double varieties of flowers contained less nectar and attracted fewer pollinators than single flowers.

There is currently limited data about pollinators, particularly in urban areas. The studies described above had varied results. For example, Makinson, Threlfall and Latty (2017) and Normandin *et al.* (2017) were not able to demonstrate statistically significant relationships between pollinator numbers and habitats, though other studies did find a largely positive relationship between pollinator numbers or diversity and certain urban habitats or management (Baldock *et al.*, 2015b Guenat *et al.*, 2018, Threlfall *et al.*, 2015). Few studies were found which specifically examined pollinator diversity or abundance in urban parks and greenspaces, and those that were found did not compare different types of management in detail (Shwartz *et al.*, 2013; Gunnarsson and Federsel, 2014). Some studies compared the attractiveness of specific species and cultivars of flowers to pollinators (Garbuzov and Ratnieks, 2014b, 2015; Rollings, 2019; Salisbury et al., 2015; Corbet et al., 2001a), but not the specific planting or management styles. There were no studies that compared different floral treatments '*in situ*' in urban parks. The current study used *in situ* surveys of pollinators in existing bedding to help inform park managers on the implications of management changes for ecosystem services.

3.5.2 Literature informing the methodology of this study

The reliability of methods of estimating pollinator abundance and diversity has been investigated by a number of authors and is the subject of ongoing research. For example Nielsen *et al.* (2011) stated that "there is an urgent need for cost-effective, reliable, and unbiased sampling methods that give good bee species richness estimates." Their study suggested that the best survey technique for bees was a combination of pan traps (coloured water-filled bowls) and transect walks (walking a pre-defined route counting insects within a certain distance from the path, including capturing the insects with nets when necessary to aid identification). However, pan traps should to be set for at least 24 hours and therefore they could be interfered with by passers-by or dogs, a particular problem in a publicly accessible space. An additional disadvantage of pan trapping is that it is destructive since the invertebrates drown in the trap. Silveira (2004) stated that sampling at flowers is usually the best technique to survey bee pollinators and that they can generally just be counted, but they may need to be collected if they are not easily identified.

Baldock *et al.* (2015a) carried out a study comparing pollinator numbers in urban parks, nature reserves and farmland in and around various UK cities. They carried out 2 m x 1 km transects at each site, taking in all of the habitats that comprised over 1% of the area of the site. They also sampled 50 x 50 cm quadrats (counts of insects in a standard sized area) containing flowers at 10 metre intervals. Similarly, Carvell *et al.* (2016) proposed and trialled a method based on fixed transect walks, timed floral observations and water-filled pan traps in their *Design and Testing of a National Pollinator and Pollination Monitoring Framework,* carried out on behalf of the Department for Environment Food and Rural Affairs. Carvell *et al.* (2016) were satisfied with the level of correlation between their three methods. Again, pan traps were not a suitable option in urban parks due to the risk of disturbance, however floral observations, which make records of insect visits over time to defined plant species within a quadrat, and transects can be used. The quadrats proposed above are similar to the British Natural History Consortium's (2017) *Pollinator Patch Surveys*, which are carried out by citizen scientists. As the locations in the present study were compared with one another, it was considered that as long as the method was consistent the results should be valid. Transects were trialled in this study in 2017, but standardised quadrats were selected subsequently as the data could be compared and analysed more readily when based on counts from a fixed area and period of observation.

As Roubik points out (cited in Food and Agriculture Organization of the United Nations, 2008) it is not unusual for bee populations to reduce by half, or to double, in the space of a year. Given fluctuations on this scale, it is difficult to establish trends without many years' worth of data and it would, therefore, not be sensible to compare two years in this way. Ideally, to reduce the effect of this problem, two sites could be compared at the same time. This was not possible in this study as there was a single observer. To reduce the effect of carrying out the surveys at a different time, the surveys at each site were carried out in periods as close to the same time and weather conditions as possible.

Research on butterflies also suggests that habitat changes may take some time to affect their numbers (Pollard, 1977). In addition Pollard suggests that trends can be compared within sites as well as being compared to national trends:

> "for most species, index values over large areas tend to fluctuate synchronously. Local site factors, such as slow habitat change, have only a small effect on annual changes, but, over a period of years, will cause index values to depart from regional or national trends."

However, a more ‘dramatic’ change in habitat may cause a significant change in insect numbers to occur more rapidly: “Only if a large part of a transect route is affected by a sudden habitat change is this likely to override these annual fluctuations” (Pollard 1977).

Within the present study, two years of data collection would not be enough to demonstrate a significant effect on pollinators over time, unless the management changes was having a particularly marked effect on numbers. But data from locations where management is changed and where it is unchanged can provide a similar comparison to ‘**before**-**after**-**control**-**impact** (**BACI**)’ management changes.

3.5.3 Timing and weather

Weather conditions and time of day are important when counting insects as they are sensitive to conditions and will only be active, and therefore visible, in suitable conditions. Some of the studies described above do not stipulate the timing or weather conditions for the surveys in much detail, or at all in some cases not at all. For example (Nielsen et al., 2011) state the months in which the surveys took place but not the time of day or weather conditions. Others are more specific about the conditions for surveys, for example, Wood, Holland and Goulson (2015) apply the UK Butterfly Monitoring Scheme (UKBMS) guidelines (2006). Carvell *et al.* (2016) suggest repeat visits between April and September in “good” weather. Similarly, Baldock *et al.* (2015a) carried out visits in May-September. Beewalk Guidelines (Bumblebee Conservation Trust, 2017) state “[i]deally, you should walk your transect between 11am - 5pm, choosing approximately the same time of day every month. It is best if the weather is warm and sunny, with no more than a light breeze.” Popic, Davila and Wardle (2013) also mention the timings they used, but as this is an Australian study these cannot be directly applied to the UK.

Butterfly Conservation's (2006) UKBMS guidelines provide a detailed set of criteria for butterfly sampling, which may be transferable to most diurnal pollinators as they have similar weather requirements, or in some cases may be less sensitive to weather conditions. For example, due to their larger body sizes, bumblebees tend be less sensitive to temperature than smaller insects; Nielsen *et al.* (2017) found that bumblebees were less sensitive to changes in ambient temperature than honey bees (*Apis mellifera*). This is reflected in the Beewalk guidelines (Bumblebee Conservation Trust, 2017) which state simply that the weather should be "warm and sunny, with no more than a light breeze" whereas the UKBMS guidelines are much more prescriptive. The UKBMS field guidance for butterfly transects gives a monitoring period of April to September. The timing of the visits should be between the hours of 10:45 and 15:45 (with 10:00 to 17:00 allowable). The UKBMS guidelines state that transects should be carried out when the weather is warm and "at least bright". There should be "no more than moderate winds" and no rain. They set out minimum conditions as follows: "either 13-17^{o}C with at least 60% sunshine, or if there is no sunshine the temperature must be 17^{o}C or above. Wind speed (Beaufort scale) should be no more than 5 unless the transect route is sheltered from the wind" (Butterfly Conservation, 2006). The UKBMS guidelines aim to provide the best chance of seeing butterflies as these are the periods and weather conditions when butterflies are most active.

3.6 Methodology

The timing and weather criteria from UKBMS guidelines were applied for this study. In 2017 each site was visited in June, July, August and September. In 2018, field visits were carried out in May, July and September. Each month, the sites were visited as close to the same date as the other sites as possible, depending on available time and weather conditions. These early, mid and late visits enabled the recording of a wide range of insects with different flight periods and the assessment of the habitat, in the key periods for pollinators.

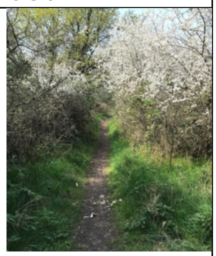
This study concentrates on bees and butterflies as they are relatively conspicuous and it is possible to carry out an identification in the field. Some bees cannot be identified to species level in the field and so these were recorded as by taxonomic level or as an aggregate species. For example, some pollinators can only be identified to species level by dissection of the genitals and examination under a microscope, hence this is not possible in the field. Workers of *Bombus terrestris* (Buff-tailed Bumblebee) and *Bombus lucorum* (White-tailed Bumblebee) cannot be distinguished in the field and were recorded as an aggregate. Similarly, some solitary bees were only identified to genus level. Bees are considered key pollinators, and their flight patterns are better understood than hoverflies (Dicks *et al.*, 2015). This understanding includes the distances they travel to forage and the weather conditions they require to be active, which assists in the planning of methodology. Bees were therefore chosen as a key focus of the study. Other species were sampled as far as possible, with all hoverflies recorded as one group, as were flies. Beetles were recorded by species or genus depending on the ease of identification.

Photographs were taken of individuals, when necessary, to aid identification. Other studies have simplified identification even further, for example Garbuzov and Ratnieks (2014) carried out brief “snapshot” counts in their experimental beds and separated bumblebees into two-banded white-tailed bumblebees, three-banded white-tailed bumblebees, brown bumblebees and ‘other’ bumblebees. Simplifications such as these enable large numbers of pollinators to be sampled quickly and without capture.

Pollinators were counted to give a measure of number of individuals and species richness which is simply the number of species and does not take into account relative abundance or rarity of the species counted. Here, the groups of pollinators that could not be distinguished were included as a pseudo-species for the purposes of analysis. Due to this simplification indices of diversity (such as Shannon’s diversity index) were not applied as these are based upon counts of species and the data collected here do not identify several groups to species level. Use of higher taxonomic ranks in biodiversity indices may introduce errors (Wu 1982; Bringloe *et al*. 2016). Macdonald *et al*. (2016) found that, in the case of butterflies, species evenness and richness were inversely related. Therefore diversity indices can inform us about the composition of an assemblage but they do not necessarily “align with our intuitive sense of species diversity” (Macdonald *et al*. 2016). This chapter, therefore, uses a simple measure of species richness as opposed to a measure of biodiversity.

Existing data were sought at the national level to assess how pollinator trends in the West Midlands compare to the rest of the country. Data were shared by Bumblebee conservation from their ‘Beewalk’ citizen science transect based monitoring project (see section 1.9). As this data includes habitat data there was potential to compare bee numbers or species richness in different habitats, this was compared to the 2017 data which also used transects. The Centre for Ecology and Hydrology also agreed to share data from their Flower Insect Timed count citizen science project, but only headline data were available at the time of writing (see section 1.10). These data were compared to the data collected for this study to help validate the results. Table 2 shows examples images of the habitats visited in 2017 in transects and quadrats.

Table 2: Showing examples of the habitats surveyed in transects and quadrats in 2017.

 Perennial Bed	 Seasonal Bed	 Pictorial Meadow	 Young Plantation
 Rose Bed/Formal Garden	 'Friends' bed	 Infrequent mow	 Lavender bed
 Closely mown grass (10 or 20 day mow)	 Hedge	 Wildflower	 Woodland

3.6.1 Transects

In 2017, transects were walked in each habitat, counting pollinators within 2m to each side of the observer and 4m in front. Fifty one transect sections were walked, which totalled 7235.5m. The transects included the following floral habitats: perennial flower beds (which are not regularly replanted), seasonal flower beds (which are regularly replanted), a formal garden inside of a park (which included mixed flower beds), Pictorial Meadows (a proprietary seed mix including non-native and native wildflowers) and wildflower areas (areas where native wildflowers have been allowed to colonise naturally). Various grass mowing regimes were surveyed, including areas that are mown infrequently (once or twice per year) or mown frequently (every 10 or 20-days in summer), and these were further differentiated into shady (with extensive tree cover) and non-shady areas. Hedges, woodland and young plantation (recently planted woodland areas) were also visited.

Pollinators that were seen were counted and, if necessary, to aid identification, they were netted to allow close inspection. Photographs were taken of individuals to aid identification. If species identity was uncertain the genus/group was recorded. Details of the habitat, management approach, such as mowing or bedding type, and any plants in flower along the transect were also recorded. The transect sections varied in length from 28 metres (a perennial bed) to 341 metres (an area of mown grass) depending on the size of the blocks of habitat. Difficulties in analysing this data arose from the lack of comparability that paired sites offer. For example, the differing lengths of the transects and the different numbers of examples of each habitat type result in issues with analysis with these relatively small sample sizes. This approach was not repeated in 2018. However, it provided a basis for the work in 2018.

3.6.2 Quadrats

In both 2017 and 2018, 2m x 2m quadrats were used to sample each floral display/habitat type to count pollinators visiting flowers for a period of 5 minutes. Fifty quadrats were used in 2017 and 72 in 2018.The same quadrat locations were visited on each occasion. The flowers were identified and the number of blooms/floral units were counted at each visit. Flowers were counted as part of the same ‘unit’ if a pollinator could walk from one to the next, for example a head, umbel or spike (Carvell, 2016). The estimated area of each flowering plant species and flower family were also recorded. The quadrat locations were photographed to allow the same area to be used in repeat visits.

These quadrats were larger than those suggested in Carvell *et al.* (2016) to allow sampling of a range of flowers in mixed beds, as opposed to a smaller area of a single species. Pollinators were not netted on quadrats as this would scare away other individuals. If individuals could not be identified *in situ*, or from a photograph, their genus/group was recorded.

The quadrats in 2017 included the following habitats: perennial flower beds (which are not regularly replanted), seasonal flower beds (which are regularly replanted), Friends bed (mixed flower beds maintained by volunteer ‘friends of the park’ groups), Pictorial Meadows (a proprietary seed mix including non-native and native wildflowers), lavender beds (predominated by *Lavandula* spp.), rose beds (predominated by ornamental roses) and wildflower areas (areas where native wildflowers have been allowed to colonise naturally).
In 2017, quadrats were located in a range of habitats and the numbers of each habitat type varied, this means it is difficult to establish statistical significance with these relatively small sample sizes. In addition, not all of the habitats were available in all of the park sites, meaning that it was difficult to allow for the effect of site in the analysis. In 2018, all of the park sites used had both types of floral bedding (seasonal and perennial). There were few sites with multiple habitat types which meant that any effect observed might have been site specific, necessitating the narrower focus in the second year of the study. These preliminary results were not used in the analysis but they are included below in Section 3.6.3.

In 2018, a total of 72 quadrats, 36 in perennial flower beds and 36 in seasonal flower beds were each visited 3 times. Pollinators were counted if they landed on a flower within the quadrat. Repeat visits by the same pollinator were not recorded. Figures 12-20 show the survey locations in 2017 and 2018.

3.6.3 Results from Preliminary Study

3.6.3.1 Data Summary, Transects in 2017

From the transects walked in 2017, a total of 2970 individual pollinators and 53 species/groups were seen. A total of 51 transect sections (blocks of habitat) and 7235.5 metres of transect were walked on 4 occasions.

A total of 745 bumblebees of 7 species were seen. The counts of Buff-tailed Bumblebee (*Bombus terrestris*) and White-tailed Bumblebee (*Bombus lucorum*) were aggregated as they cannot be separated reliably in the field, giving 6 species/groups. This aggregate count contained the most individuals (N=340). The largest number of a single species (excluding the aggregate) was of Red-tailed bumblebee (*Bombus lapidarius*) with 200 individuals. Just 3 Garden Bumblebees *(Bombus hortorum)* were seen on the transects. Three cuckoo bumblebees were seen, which most likely belonged to the species Vestal Cuckoo Bumblebee *(Bombus vestalis)* or possibly Gypsy Cuckoo Bumblebee *(Bombus bohemicus)*.

Seventeen solitary bees belonging to 4 species were seen (including Wool Carder Bee [Anthidium manicatum] Figure 12) and 299 Honey Bees (*Apis mellifera)* were counted.

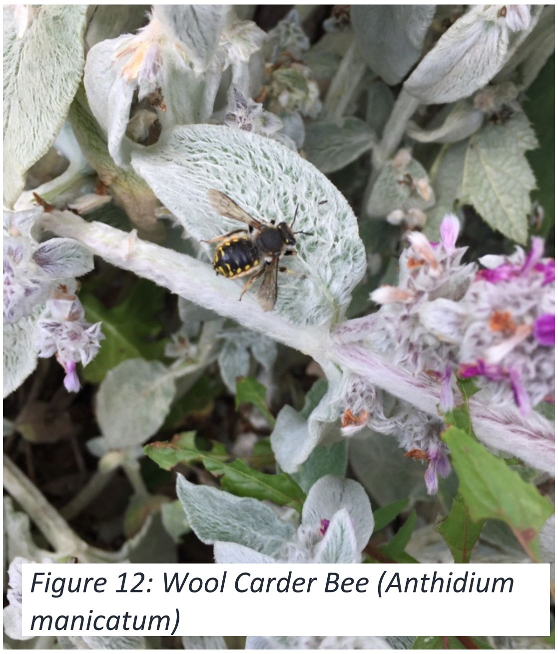


Figure 12: Wool Carder Bee (Anthidium manicatum)

A total of 187 butterflies were observed along the transects, belonging to 16 species. The species most commonly seen was the Speckled Wood (*Pararge aegeria*) with 52 individuals. For Holly Blue (*Celastrina argiolus*) and Small Copper (*Lycaena phlaeas*), just one individual was seen of each species. A total of 43 moths (including 8 moth caterpillars) were recorded belonging to 4 species, plus a group for micro-moths, which were not readily identifiable in the field.

Finally, 545 hoverflies and 699 other flies were counted, 375 beetles of 7 species, 29 wasps, 4 shield bugs, 15 damselflies and 4 dragonflies.


Figure 13: Pictorial Meadow planting

In 2017 transects (Table 3) the pollinators were most abundant and species richness was greatest in perennial beds, followed by other flower-rich habitats such as mixed beds, formal garden and Pictorial Meadow plantings (Figure 13). Wildflowers were the only flower rich habitat that ranked below seasonal bedding in terms of pollinator abundance and species richness, probably because the examples visited were not particularly flower-rich. Of the less flower-rich habitats, shady grass mowed on a 10-day cycle had the fewest pollinators. It was not possible to perform robust analyses due to the different numbers of samples from each habitat type, and as examples of each habitat type were not available in each park, it was not possible to allow for spatial effects.

Table 3: Mean number of pollinators per metre observed along transects in 2017. The data are sorted by the mean number of individuals per metre.

Habitat	Mean no. individuals/metre	Mean no. species/metre	No. transect sections	Total metres
Perennial bed	0.5510	0.1220	4	149.02
10-day mow + mixed beds	0.2930	0.0193	1	50.29
Formal garden (in park)	0.2910	0.0529	2	273.34
Pictorial meadow	0.2910	0.0402	4	407.72
Young plantation	0.1280	0.0329	3	425.58
Seasonal bed	0.1070	0.0450	1	44.46
Wildflower	0.0871	0.0107	2	441.74
Infrequent mow	0.0859	0.0259	8	1412.56
10-day mow	0.0624	0.0161	7	1277.63
20-day mow	0.0483	0.0173	10	1504.09
Shady 20-day mow	0.0449	0.0148	2	337.41
Hedge	0.0408	0.0168	3	452.53
Woodland	0.0185	0.0123	1	162.45
Shady 10-day mow	0.0171	0.0058	2	426.21

3.6.3.2 Data Summary, Quadrats in 2017

In 2017, 819 individual pollinators and 28 species/groups were recorded in the 50 quadrats, with four observation visits made to each quadrat. As far as possible, further visits by the same individual insect were ignored (for example when an individual is seen going from one flower to another), so this represents 819 individual pollinators. Pollinators were not recorded if they were not visiting a flower or were outside of the quadrats (see Table 4).

Of the 819 individuals seen, 307 were social bumblebees. The records of Buff-tailed Bumblebee (*Bombus terrestris*) and White-tailed Bumblebee (*Bombus lucorum*) were also aggregated for the quadrats, giving 6 species/groups. The greatest number of bumblebees belonged to the *lucorum/terrestris* aggregate (151 individuals). Not including the *lucorum/terrestris* aggregate, the greatest number of a single species of bumblebee was Common Carder (*Bombus pascorum*) with 91 individuals. Only 4 individuals each of Tree Bumblebee *(Bombus hypnorum)* and Garden Bumblebee *(Bombus hortorum)* were seen. A total of 14 cuckoo bumblebees were seen, these were most likely to belong to the species Vestal Cuckoo Bumblebee *(Bombus vestalis)* or possibly Gypsy Cuckoo Bumblebee *(Bombus bohemicus).* These were not identified to species level, as capturing them would cause disturbance during a timed assessment.

A total of 24 solitary bees were seen, belonging to 7 species/groups. The largest number of individuals of any species were 6 Yellow-legged Mining-bees *(Andrena flavipes).* A total of 156 Honey Bees were seen (*Apis mellifera),* making it the most common bee species in quadrats in 2017.

With regard to insects other than bees, 231 hoverflies and 66 other flies were counted, which were not identified beyond these groups. There were 12 beetles of 4 species, 5 wasps and a single individual of each of 4 species of butterfly were counted.

Overall, quadrats from wildflower areas had the greatest species richness and abundance of pollinators, followed by perennial bedding, then Pictorial Meadow plantings. Seasonal beds, mixed beds and rose beds had the lowest species richness and abundance of pollinators (see Table 4). Statistical significance could not be robustly demonstrated due to the varied number of samples in each habitat.

These results, and the problems with analysis, led to a more focused study in 2018, where paired samples of flower beds within each park were used.

Table 4: Mean number of pollinators per quadrat in 2017 in parks in Coventry.

Management	**Mean No. Individuals/ Quadrat**	**Mean No. Species/ Quadrat**	**No. quadrats.**
Wildflower area	34.0	7.00	2
Perennial beds	25.2	5.75	18
Pictorial meadow	22.0	4.75	4
Lavender beds	19.6	3.80	2
Friends (beds maintained by volunteers)	16.0	5.00	2
Shrubby perennial beds	7.00	3.00	2
Seasonal beds	6.08	2.00	15
Mixed beds	5.50	1.50	2
Rose beds	3.00	1.67	3

3.6.4 Habitat

The habitat at each site was assessed and scored at each visit. This allowed the amount of early, mid and late summer forage for pollinators to be evaluated along with other habitat features such as potential nesting sites and neighbouring land use. The method was based on work from The Xerces Society for Invertebrate Conservation (2014) and Buglife (2012) and adapted for the UK/urban park setting by including the habitats/features relevant in these locations. The resulting scores were used in the analysis to allow for the effect of the site on the results. See Appendix 1.2 for the habitat recording form.

3.6.5 Site and Quadrat Selection

In 2018, sites were selected where the two types of bedding were available within the same park/greenspace to allow surveys to be undertaken as close to the same time as possible, and to reduce the effects of location on the findings. Pollinators will travel for some distance to forage, for example Osborne *et al.* (2008) found that bumblebees are able to forage 1.5 km from their colony, possibly further. It is harder to measure the foraging distances of non-colonial pollinators as they may not return to the same location after foraging but other pollinators may travel some distance. Wotton *et al.* (2019) state that marmalade hoverflies (*Episyrphus balteatus*), a common species, including in urban areas, regularly migrate between mainland Europe and the UK. Butterflies vary in their range, some species migrate long distances while others tend to remain in a particular site (Wood and Pullin, 2002). Two habitats within a few hundred metres of one another can be compared, with the assumption that many pollinators could readily move between them, and it should therefore be possible to use the data to demonstrate a preference for a particular habitat.

In Coventry, four of the sites used in 2017 had seasonal and perennial bedding, so they were used again in 2018. In order to reduce the impact of site specific effects on the results, further sites with seasonal and perennial bedding were located by contacting all of Coventry's neighbouring local authorities. This strategy sought to reduce the effect of location/climate upon pollinator counts. These enquiries provided three new sites in Rugby, Warwick and Leamington Spa. The other neighbouring authorities (Nuneaton and Solihull) had no suitable sites. All of the suitable sites were included in the field work, as were all of the suitable flower beds. If there were more examples of one type of bedding than the other, the examples with a variety of plants, and few gaps in the planting were used in order to maintain equal numbers of samples between the two types of bedding. The location of the quadrat was randomly selected by dividing the bed into sections and using a random number generator to select the section to be assessed. The locations are shown in figures 14-22.

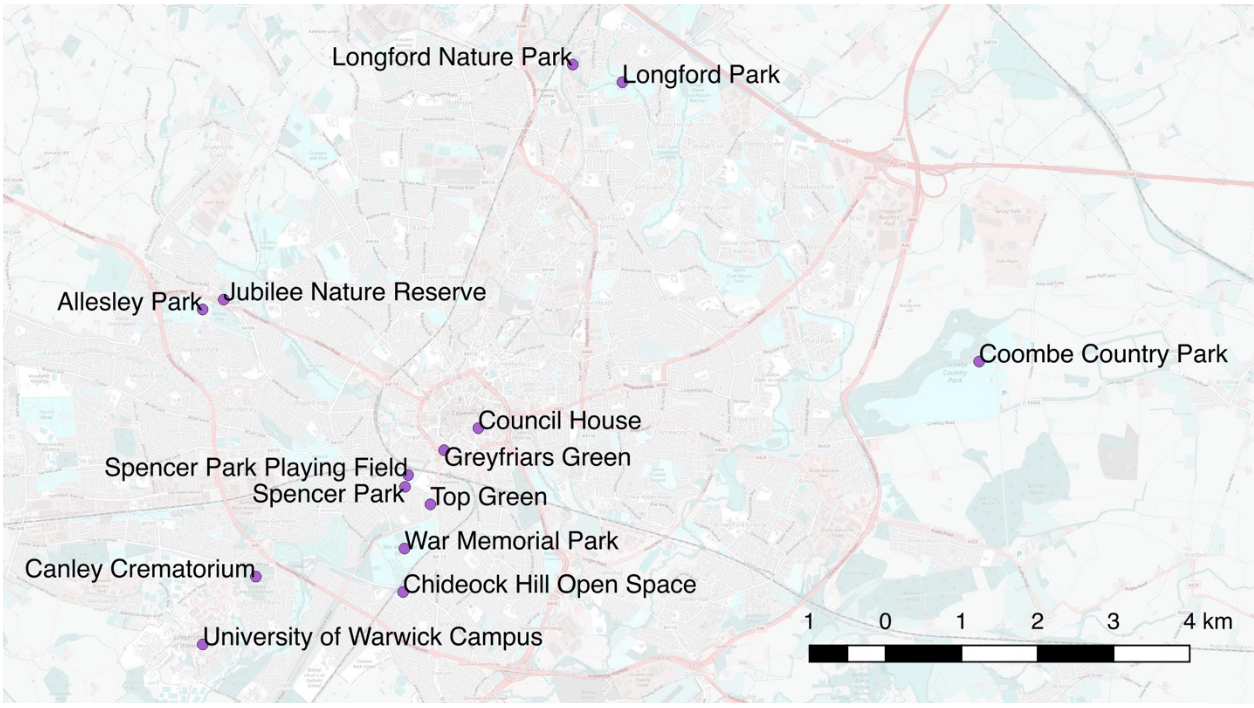


Figure 14: Map showing locations of survey sites in greenspaces in Coventry in 2017. Base map from OpenStreetMap (2017). Map created in QGIS (2017).

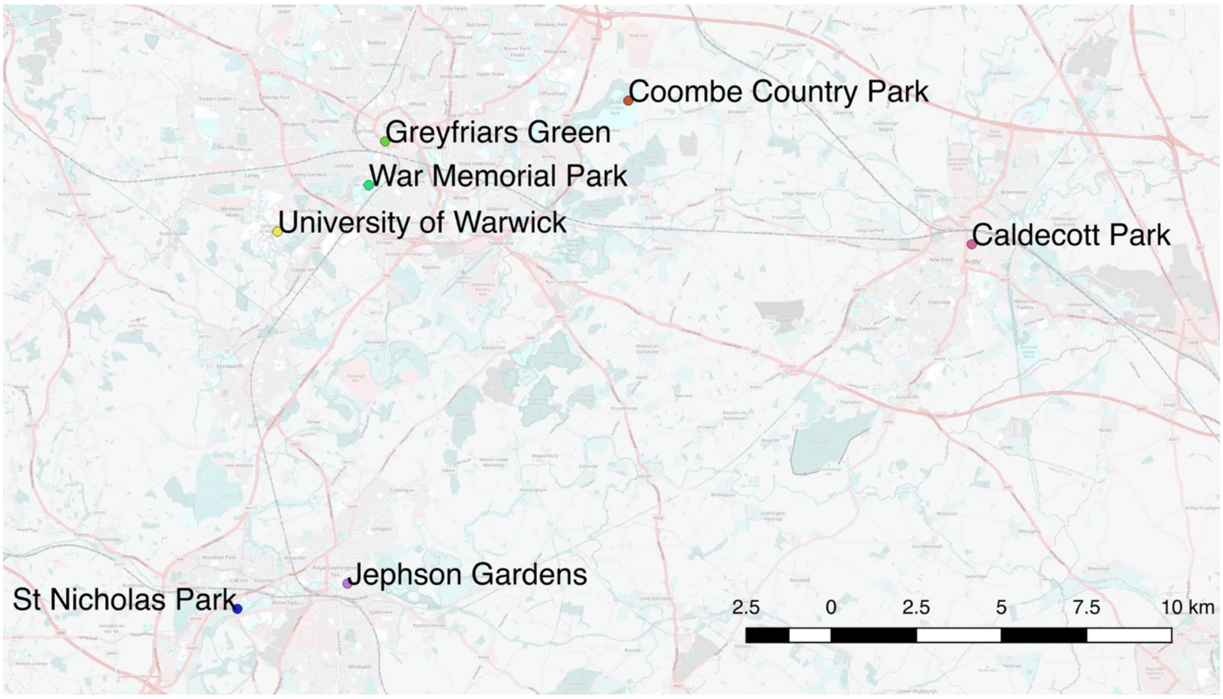


Figure 15: Map of 2018 pollinator survey quadrat locations in the West Midlands. Figures 14-20 give the exact quadrat locations within each greenspace. Base map from OpenStreetMap (2017). Map created in QGIS (2017).

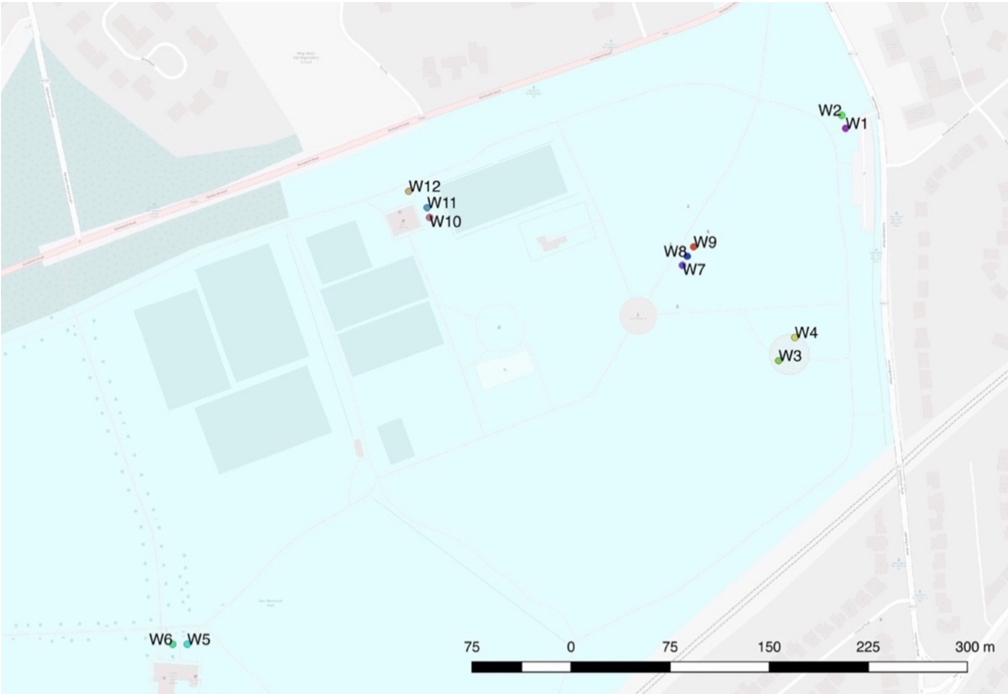


Figure 16: Locations of pollinator quadrats in War Memorial Park, Coventry. W1 to W6 are perennial beds, W7 to W12 are seasonal beds. Base map from OpenStreetMap (2017). Map created in QGIS (2017).

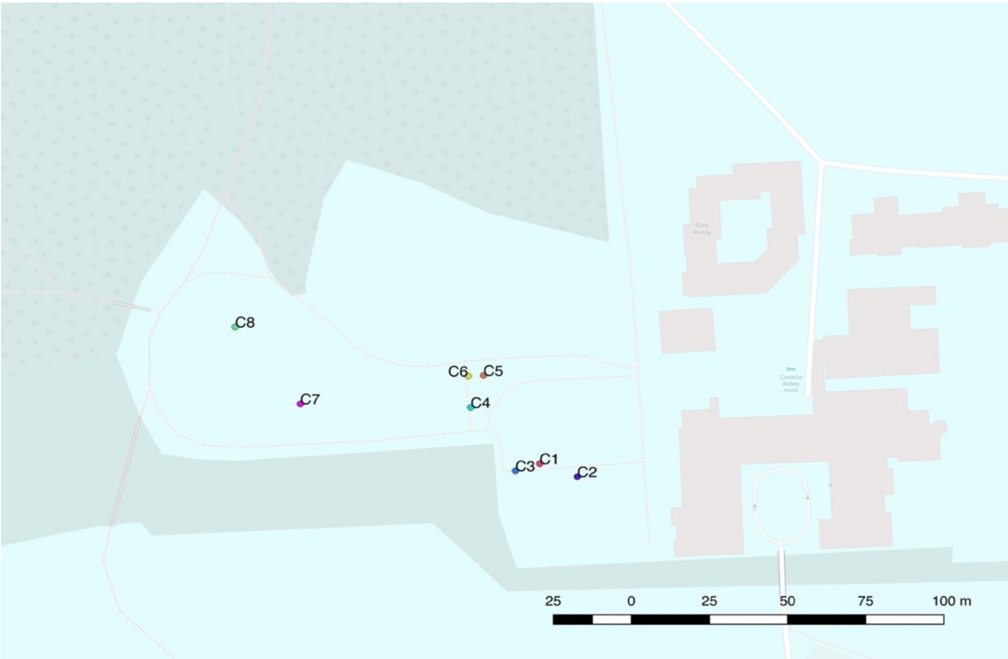


Figure 17: Locations of pollinator quadrats in Coombe Country Park, Coventry in 2018. C1 to C3 and C8 are seasonal beds, C4 to C7 are perennial beds. Base map from OpenStreetMap (2017). Map created in QGIS (2017).

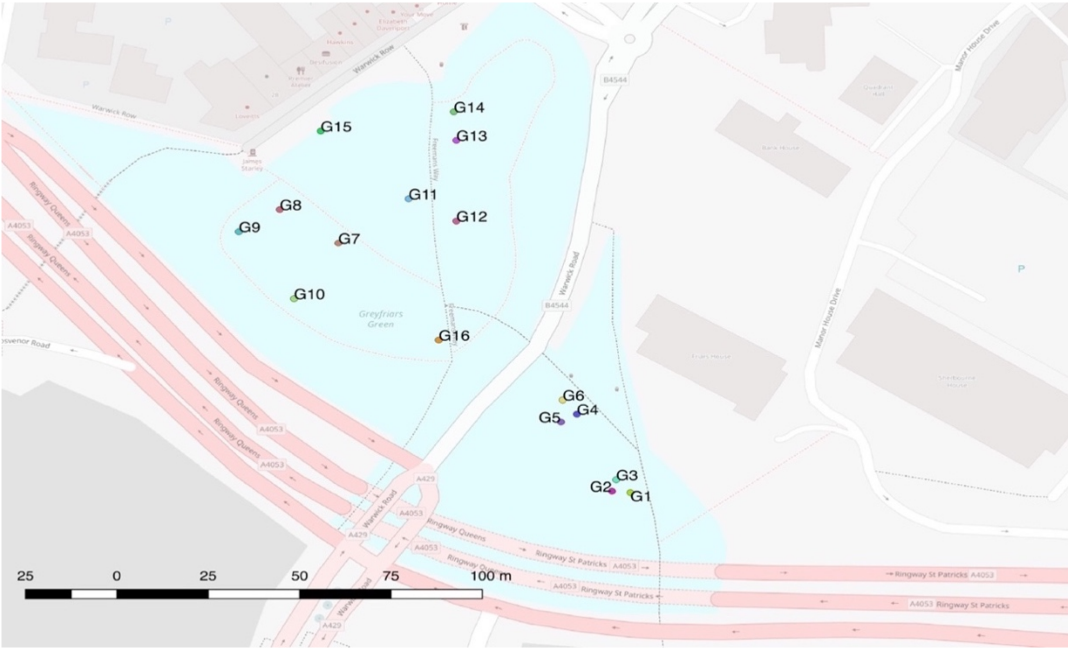


Figure 18: Locations of pollinator quadrats in Greyfriars Green, Coventry. G1 to G6 and G15 are perennial beds and G7 to G14 and G16 are seasonal beds. Base map from OpenStreetMap (2017). Map created in QGIS (2017).

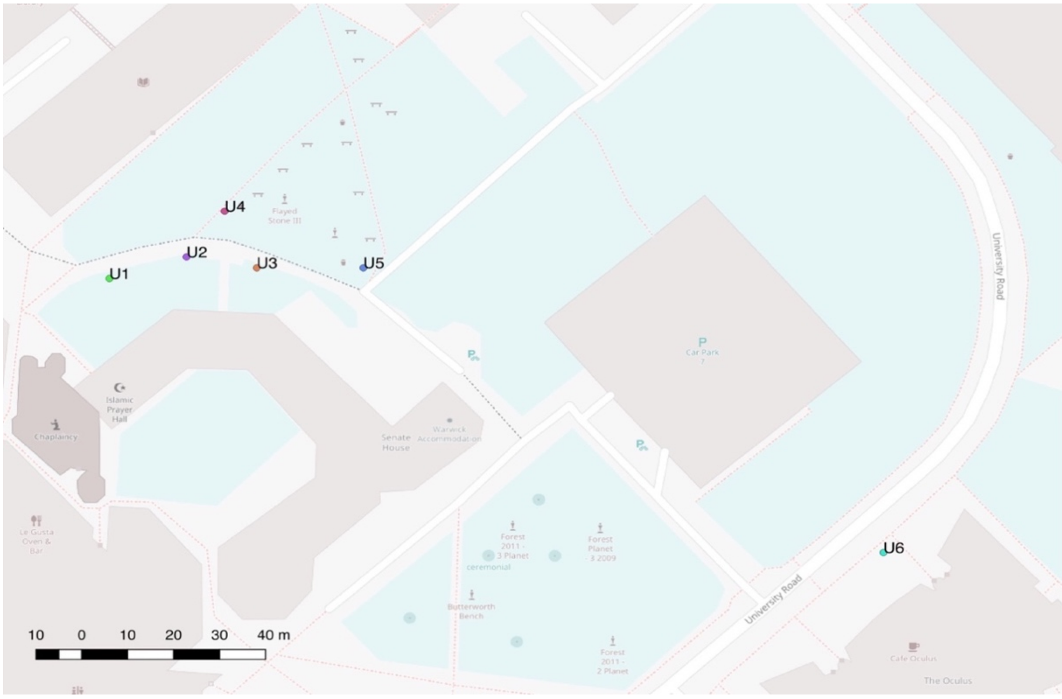


Figure 19: Locations of pollinator quadrats in University of Warwick, Coventry. U1 to U3 are perennial beds and U4 to U6 are seasonal beds. Base map from OpenStreetMap (2017). Map created in QGIS (2017).

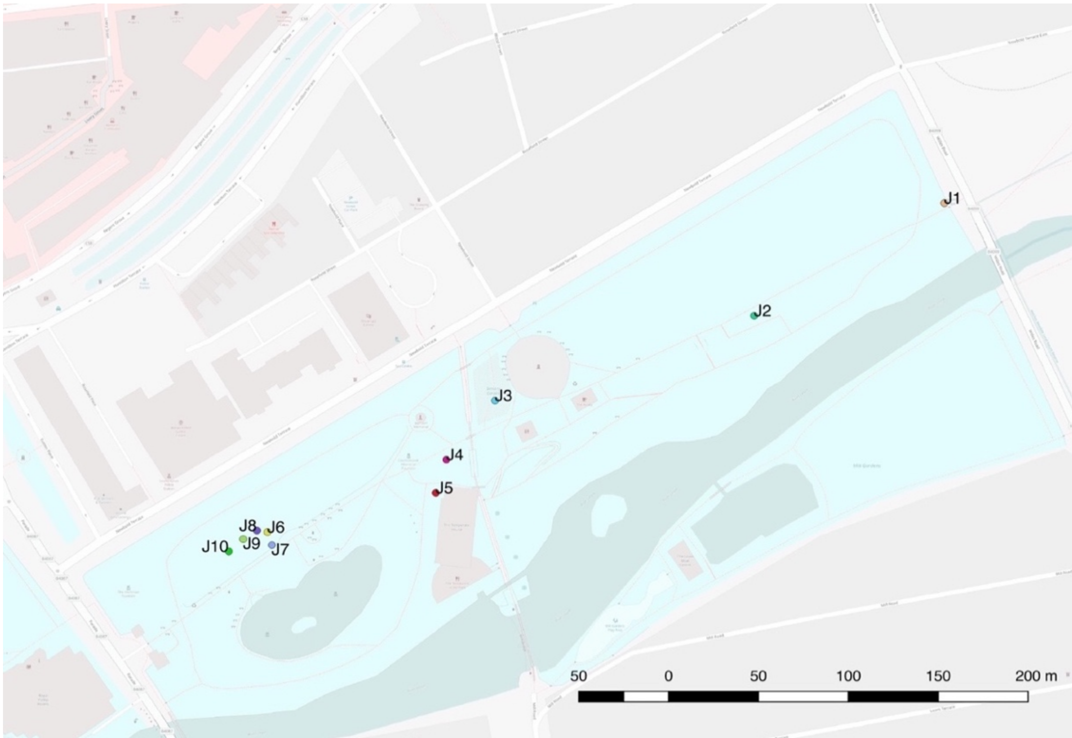


Figure 20: Locations of pollinator quadrats in Jephson Gardens, Leamington Spa. J1 to J5 are perennial beds and J6 to J10 are seasonal beds. Base map from OpenStreetMap (2017). Map created in QGIS (2017).

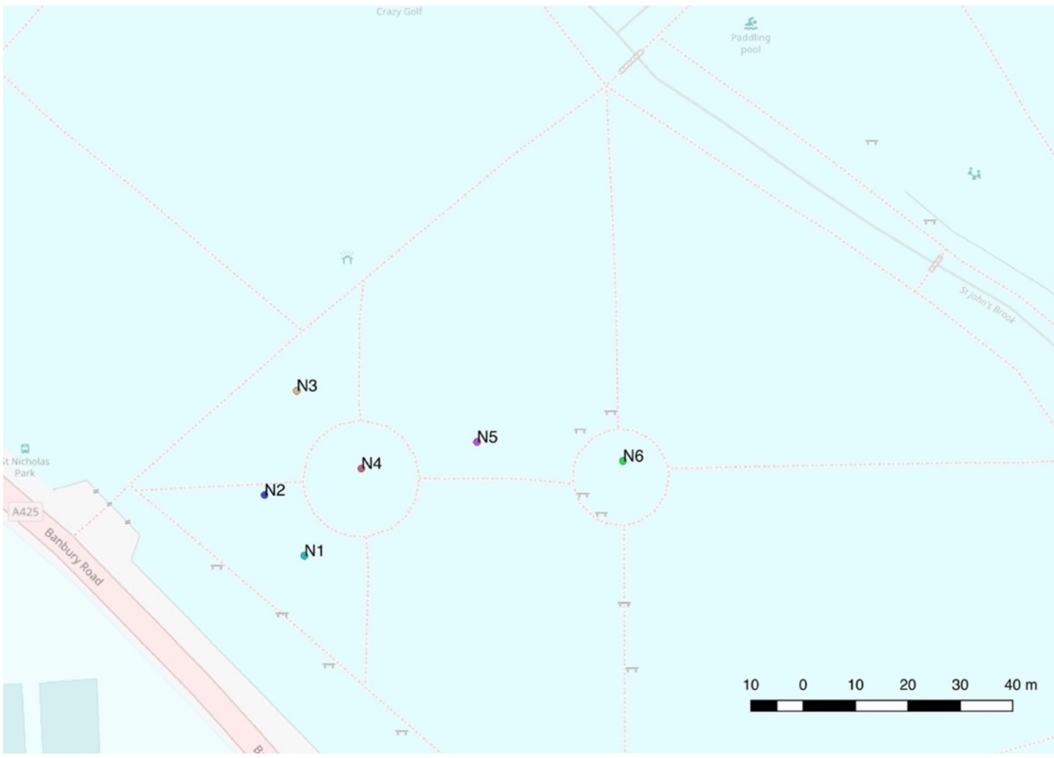


Figure 21: Locations of pollinator quadrats in St Nicholas Park, Warwick. N1 to N3 are perennial beds and N4 to N6 are seasonal beds. Base map from OpenStreetMap (2017). Map created in QGIS (2017).

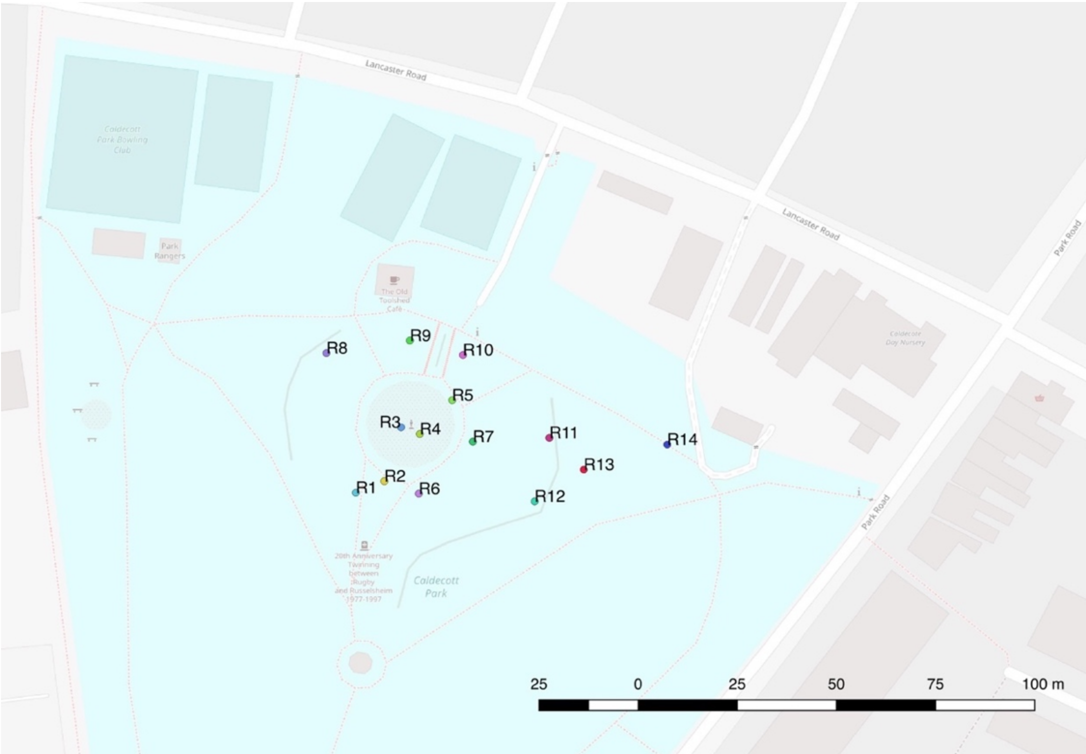


Figure 22: Locations of pollinator quadrats in Caldecott Park, Rugby. R8 to R14 are perennial beds and R1 to R7 are seasonal beds. Base map from OpenStreetMap (2017). Map created in QGIS (2017).

3.6.6 Software

All maps were created in QGIS (2017) software using base maps from OpenStreetMap (2017). Data were visualised with R (Core Team, 2017), the statistical computing programming language, using the ggplot2 package (Wickham, 2009). Data were analysed in R using the MASS (Ripley, 2011), boot (Canty and Ripley, 2017), car (Fox et al., 2014) and lme4 packages (Bates et al., 2018).

3.6.7 Analysis

The data from 2018 fieldwork were analysed using Generalised Linear Models (GLMs) to model the number of pollinators individuals and species/groups against the habitats to examine whether differences were statistically significant. Generalised linear models allow the modelling of response variables with a non-normal distribution. Measurements of weather conditions were included in the models to ensure that variations in weather between the visits was not affecting the results. Data on bumblebees were analysed separately to investigate whether this group showed the same patterns as pollinators as a whole. A separate analysis was not performed for other groups, such as solitary bees and butterflies, as there were insufficient data for robust analyses.

Habitat scores were included in later analyses to account for the effect of site specific variations. Mixed models were also used to account for site specific effects of the different parks in which the quadrats were located. Mixed models assign an intercept and slope to each random/grouping effect, allowing the effect of site to be accounted for in the model.

Data were analysed separately by month to examine whether there were differences between the three visits. Mixed models were also used to account for the effect of the month of the visit. The effect of the number of floral units and the number of species of flower were also investigated.

Negative Binomial models were selected as these are well suited to the data, which consists of over-dispersed count data with many zeros (Figure 23 and 24). Poisson models were also tried but were less suitable due to the number of zeros and the large differences between the means and variances. This leads to a higher residual variance and is an indication that the model is not suited to the data. Negative Binomial models were applied (See Appendices 1.6 – 1.9) with and without inclusion of the site as a variable (park), habitat score and the floral resource.

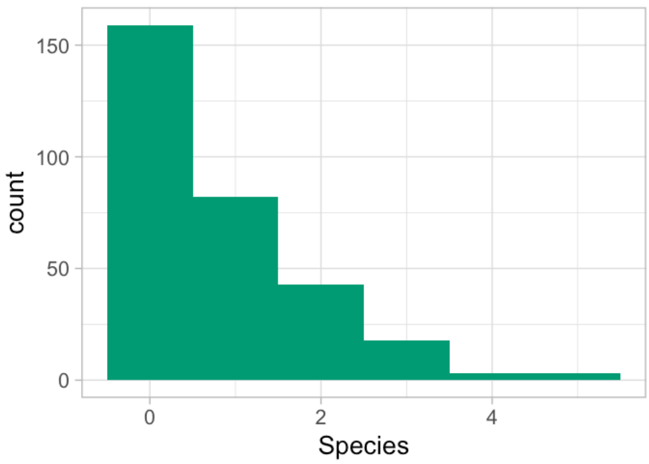


Figure 23: Histogram showing the distribution of numbers of individual pollinators in all quadrats, this distribution is not Gaussian, and is closer to a Negative Binomial distribution meaning that it is suited to analysis using Negative Binomial models.

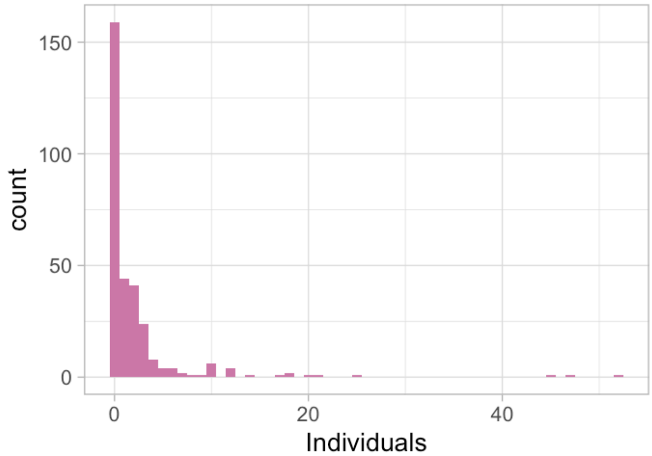


Figure 24: Histogram showing distribution of numbers of pollinator species/groups in all quadrats per count, this distribution is not Gaussian, and is closer to a Negative Binomial distribution meaning that it is suited to analysis using Negative Binomial models.

Recent literature suggests that using a model that best fits the data is preferable to the transformation of count data to allow Gaussian models to be used. For example, Warton *et al.* (2016) state that selecting a model which fits the existing distribution of the data leads to better power properties and O'Hara and Kotze (2010) found that the performance of models using transformed data was poor, except where mean counts were large and dispersion was small. O'Hara and Kotze (2010) found that the performance of Negative Binomial and quasi-Poisson models was consistently good, and that there was little bias.

Independent variables were checked for collinearity using the VIF (variable inflation factor) function, in the car package in R (Fox et al., 2014). Some variables might have been expected to have strong correlations with one another, for example low temperatures may correlate with high cloud cover, or in the case of multicollinearity both could also correlate with windspeed, which could lead to an unstable model. All variance inflation factor scores were close to one, meaning that there was not a problem with collinearity in the data.

3.7 Results

3.7.1 Data Summary, Quadrats in 2018

A total of 690 pollinator visits to flowers were recorded from the 72 quadrats during 3 visits to each in 2018. Further visits by the same individual insect were ignored therefore this represents 690 individual pollinators. Pollinators which were not visiting a flower (for example sitting on a leaf or flying over), or were not inside of the quadrats, were not recorded as this is provides a measure of only the number of pollinators using the floral resource.

Seven species of bumblebee were seen visiting flowers, with a total of 179 individuals. The greatest number of bumblebees belonged to the *lucorum/terrestris* aggregate (76 individuals) and the greatest number of a single species of bumblebee was for the Common Carder (*Bombus pascuorum*) with 63 individuals. The least recorded bumblebee was the Garden Bumblebee *(Bombus hortorum)* with just 2 individuals seen.

Five species/groups of solitary bee were seen. Many species of solitary bee are difficult, or in many cases impossible, to identify in the field. Insects were not captured as this would cause too much disturbance to a timed quadrat. Therefore, two of these species/groups were identified to genus level only. Those which could not be identified to genus level were added to a sixth category: ‘unknown solitary bee’ (12 individuals). Only a small number of solitary bees (27) were seen, the largest number were Hairy-footed Flower Bees *(Anthophora plumipes)* with 5 individuals. Honey Bee (*Apis mellifera)* was the most abundant species of bee with 124 individuals.

Wasps were separated into social wasps (8 visits) and solitary wasps (2 visits). A single European hornet *(Vespa crabro)* was also recorded visiting a flower.

Hoverflies were recorded as one group and 90 individuals were recorded visiting flowers. Similarly, 27 other flies were recorded as a group, and a single sawfly was recorded.

Few butterflies were seen, just 13 individuals across 5 species. There were 4 individuals each of Small White (*Pieris rapae*) and Small Skipper (*Thymelicus sylvestris*) and a single individual each of Small Copper (*Lycaena phlaeas*) (Figure 26) and Holly Blue (*Celastrina argiolus*).

Figure 26: Small Copper (Lycaena phlaeas)

Four species/groups of beetle were seen visiting flowers. Pollen beetles (*Meligethinae sp.)* were the most abundant group in the whole survey, with 224 individuals. Two Seven-spot ladybirds *(Coccinella septempunctata),* one Harlequin Ladybird (*Harmonia axyridis*), an invasive non-native species, and one Soldier Beetle (*Rhagonycha fulva*) were also seen. See Table 5 for a summary of the pollinators seen in 2018.

Table 5: Number of pollinators per quadrat in 2018. A total of 72 quadrats, 36 in seasonal bedding and 36 in perennial bedding, in 7 greenspaces in the West Midlands.

	Perennial bedding: No. Species/ groups	**Seasonal bedding: No. Species/ groups**	**Total no. Species / groups**	**Perennial bedding: No. Individuals**	**Seasonal bedding: No. Individuals**	**Total No. Individuals**
Bumble bees	6	5	**6**	130	39	**169**
Solitary bees	5	0	**5**	27	0	**27**
Honey bee	1	1	**1**	100	24	**124**
Wasps	3	1	**3**	8	3	**11**
Hoverflies (aggregate)	1	1	**1**	61	29	**90**
Flies (aggregate)	1	1	**1**	16	11	**27**
Sawfly	0	1	**1**	0	1	**1**
Butterflies	5	3	**5**	6	7	**13**
Beetles	4	1	**4**	166	62	**228**
Total	**26**	**14**	**27**	**514**	**176**	**690**

3.7.2 Habitat scores

Habitat scores for each park are shown in Table 6 below (see also: Appendix 1.2: Habitat recording form). Coombe Country Park scored the highest. It is a large, diverse site surrounded by countryside, offering a good range of habitats to pollinators and good connectivity to the wider landscape. Greyfriars Green scored the lowest, it is a small, formal site surrounded by man-made structures. These scores were included in later analyses to help account for the effect of location on the results.

Table 6: Scores for habitat for pollinators in the survey sites in the West Midlands. Higher scores indicate better habitat.

Park	Habitat score /130
Coombe Country Park	94
War Memorial Park	66.42
St Nicholas Park	55
Jephson Gardens	51.23
Caldecott Park	43.11
Warwick Campus	41.03
Greyfriars Green	40

3.8 Quadrats in 2018, initial plots

An initial exploratory plot of the data from the quadrats in 2018 suggests that overall the numbers of species/groups and abundance of pollinators were higher in perennial bedding compared to seasonal bedding (see Figure 27). Some seasonal bedding quadrats had greater numbers of species groups than some perennial quadrats. Similarly, Figure 28 shows higher numbers of individual pollinators in the perennial bedding quadrat, than in seasonal bedding quadrats overall; with some seasonal bedding quadrats having more individuals.

The difference between the number and species richness of pollinators visiting the two types of floral bedding is investigated further in the analysis below.

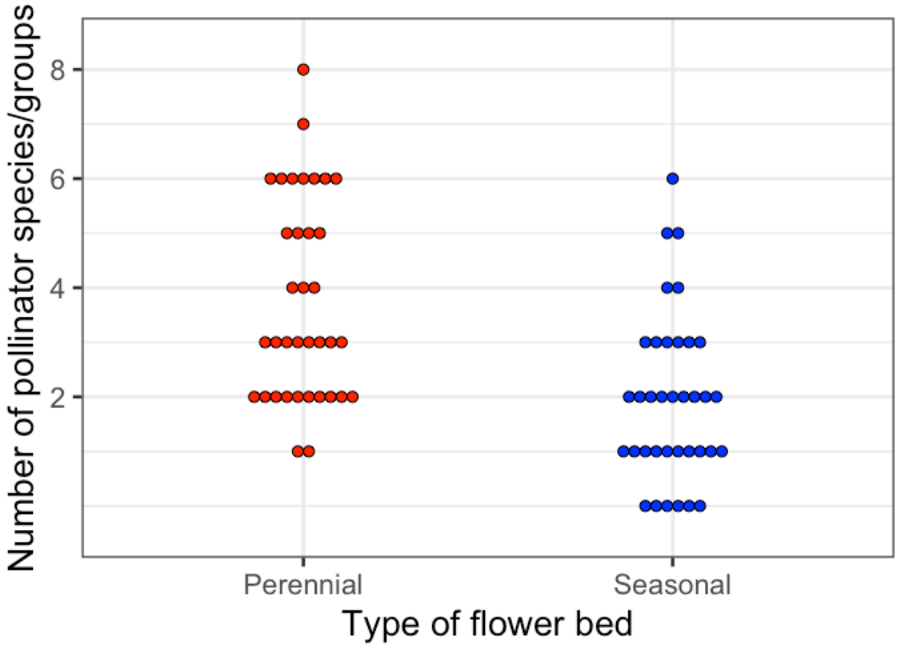


Figure 27: Dot plot of the number of pollinator species/groups per quadrat in 2018, for a total of the 3 visits (May, July and September), in perennial and seasonal bedding. Each point represents a quadrat. Horizontal jitter is applied to show points which otherwise overlap.

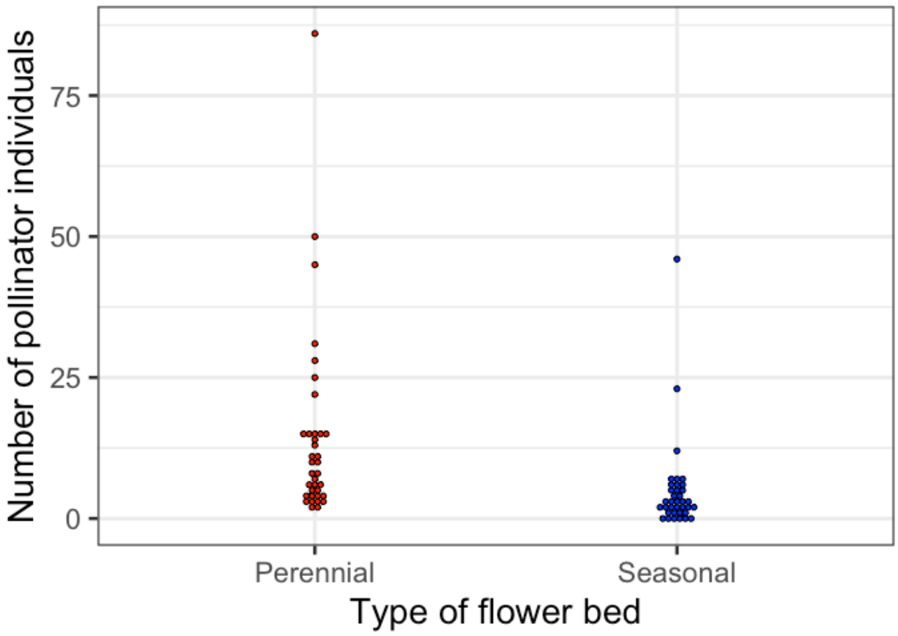


Figure 28:Dot plot of the number of individual pollinators per quadrat in 2018, in total across the 3 visits (May, July and September), in perennial and seasonal bedding. Each point represents a quadrat. Horizontal jitter is applied to show points which otherwise overlap.

3.8.1 Number of Individuals

With the effect of weather included, the Negative Binomial model for the number of individuals per quadrat (Appendix 1.4: model 2) indicated that in relation to the reference habitat (perennial bedding), and holding all other variables equal, a lower number of individual pollinators were recorded in seasonal bedding (p<0.001; coefficient estimate -1.072). Therefore, given the data and the model, perennial bedding in parks had a statistically significantly higher number of insect visits compared with seasonal bedding. A Quasi-Poisson model (Appendix 1.4: model 3) gave similar results but had a much higher residual deviance (Negative Binomial 80.046, Quasi-Poisson 646.68). Higher residual deviance suggests that the model is a poorer fit for the data, so this provides strong evidence that the Negative Binomial model was a better fit for the data.

When ‘park’ (the greenspace in which the survey took place) was added as a categorical independent variable in the model (Appendix 1.4: model 4) none of the sites had a statistically significant positive effect on pollinator numbers. The following sites had a statistically significant negative effect on pollinator numbers (listed in order of magnitude): The University of Warwick Campus, War Memorial Park, Coombe Country Park and Greyfriars Green. This suggests that quadrats at these sites had fewer pollinator visits in their seasonal beds in relation to their perennial beds. The other sites did not have a statistically significant effect. Site specific effects were investigated further using mixed models later in the analysis (see “Effect of Park” below).

When the habitat score was added to the base model (with weather) (Appendix 1.4: Model 7) the effect was small (coefficient estimate 0.003) and not statistically significant. However, it increased the negative effect of seasonal bedding (coefficient estimate -1.839) suggesting that there is an interaction between these model terms.

AIC (Akaike Information Criterion) is a measure used for model selection, based on estimation of out-of-sample prediction error; a lower score suggests a higher quality model (Vrieze, 2012). The lowest AIC score (445.503), therefore the best fitting model, was for the model which included weather, park and number of flower blooms (Appendix 1.4: model 6). The effect of the number of blooms was small (coefficient estimate 0.003) but statistically significant at $p<0.001$.

3.8.2 Species/groups

The Negative Binomial model for the number of species/groups per quadrat, with the effect of weather included (Appendix 1.3: model 2), indicated that in relation to the reference habitat (perennial bedding), and holding all other variables equal, a lower number of species/groups were recorded in seasonal bedding ($p<0.001$; coefficient estimate -0.654). This suggests that the perennial bedding in parks had a statistically significantly higher number of species/groups of pollinators visiting compared with seasonal bedding. The Quasi Poisson model (Appendix 1.3, model 3) gave similar results to the Negative Binomial model. However, the Quasi Poisson model had a slightly higher residual deviance (Negative Binomial 75.511, Quasi Poisson 75.518) which suggests that the Negative Binomial model more closely represented the data.

When the effect of ‘park’ was added (Appendix 1.3: model 4) none of the sites had a statistically significant positive effect on the number of species/groups of pollinators. In order of magnitude, the War Memorial Park, University of Warwick Campus, Greyfriars Green and Coombe Country Park, had a statistically significant negative effect on the number of species/groups of pollinators, suggesting that quadrats at these sites had fewer pollinator species in their seasonal beds in relation to their perennial beds. Effects of the location (park) on species/groups is investigated (alongside the effect on individuals) through mixed models (see “Effect of Park” below).

There was a small effect of the habitat in and around the park on pollinator preferences for seasonal or perennial bedding. When the effect of habitat score was added (Appendix 1.3, Model 7), the effect was slight (coefficient estimate 0.003) and not statistically significant, but it increased the effect of seasonal bedding (coefficient estimate -1.029).

The lowest AIC score (268.377) was for the model which included weather and the number of flower blooms (Appendix 1.3, model 5). The effect of the number of flower blooms was small (coefficient estimate 0.002) but statistically significant at $p<0.001$ suggesting that the number of flowers only had a small positive effect on pollinator preference, but it did improve the model.

3.8.3 Bumblebees

Different species/groups of pollinators have different habitat requirements, for example the length of the pollinators' tongue affects the types of flowers from which they can feed. In this relatively small study, there were insufficient data to perform robust analyses by species. As bumblebees are a key pollinator group and provided enough examples to allow for an independent analysis, they were examined separately as a group, although it is recognised that resource requirements will vary within this group. There were too few records of the other groups of interest, e.g. butterflies, solitary bees, to analyse these separately.

For bumblebees (Appendix 1.5: Bumblebee models model A), the relationship between number of pollinator species/groups and flower beds and was significant at $p<0.01$. Seasonal bedding had a negative effect on the number of species/groups (coefficient estimate -0.672) showing that the 'preference' for perennial beds is consistent with the overall results for this group. (See Figure 29)

Fewer individual bumblebees per quadrat were associated with seasonal bedding than perennial bedding ($p<0.001$; coefficient estimate -1.204) (Appendix 1.5: Bumblebee models model B). Perennial beds were preferred by bumblebees when compared to seasonal beds, as in the overall results for all pollinator groups (See Figure 30).

Overall, the pattern for bumblebees preferences followed the patterns for all pollinator groups. The coefficients were also similar to those for all groups. As bumblebees were included in the models for all groups, and were numerous, the results were obviously likely to follow a similar pattern.

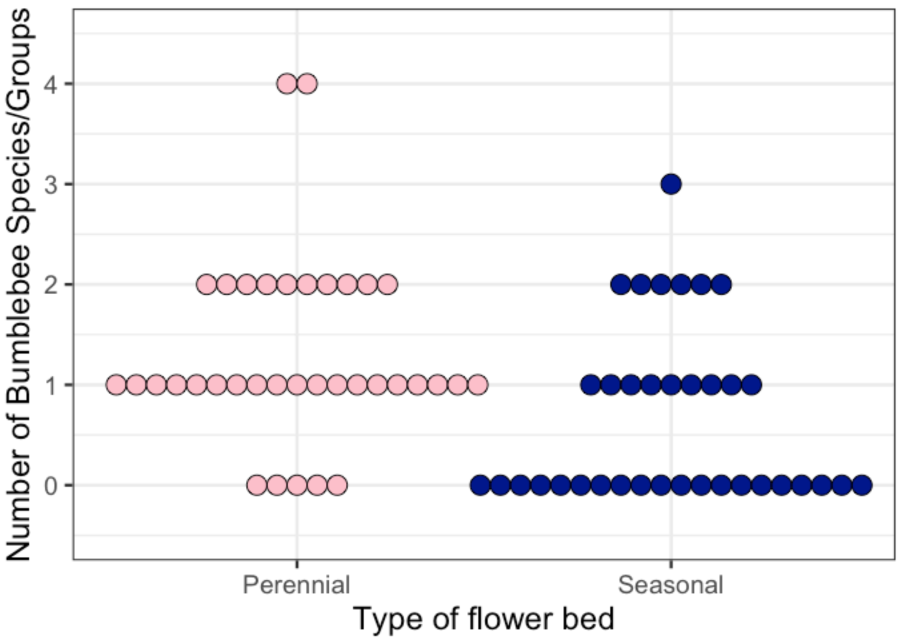


Figure 29: Dot plots of the number of bumblebee species/groups per quadrat. Each point represents a quadrat. Horizontal jitter is applied to show points which otherwise overlap.

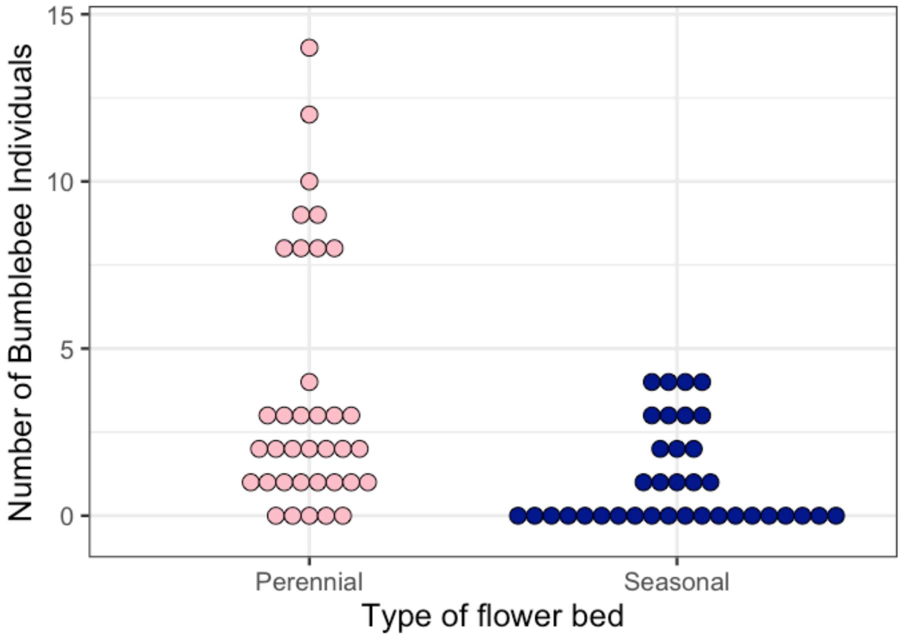


Figure 30: Dot plot of the number of bumblebee individuals per quadrat. Each point represents a quadrat. Horizontal jitter is applied to show points which otherwise overlap.

3.8.4 Effect of park

As the quadrats were nested within the parks there was potentially an issue with pseudoreplication; which is the treatment of samples as independent when they are actually inter-dependent. Hurlbert (1984) states that pseudoreplication is “the use of inferential statistics to test for treatment effects with data from experiments where either treatments are not replicated (though samples may be) or replicates are not statistically independent.” If pseudoreplication was shown to be an issue with the sampling strategy or data analysis, this could result in a reduction in the number of true replicates from 36 (the number of paired quadrats) to 7 (the number of parks). To further investigate the effects of the site (park) ‘small multiple’ dot plots were created for species/groups and individuals (see Figure 31 and Figure 32). Small multiple plots are a series of small graphs within one graphical layout, with common axes and encodings (Munzner, 2014). They are useful where plotting all of the data in a single plot would result in a graph which is difficult to read. The small multiple plots suggest that, overall, all sites had greater numbers of individuals and species richness of pollinators in perennial than seasonal quadrats, though some seasonal quadrats have more pollinator visitors than some perennial quadrats. The statistical significance of this difference is investigated below.

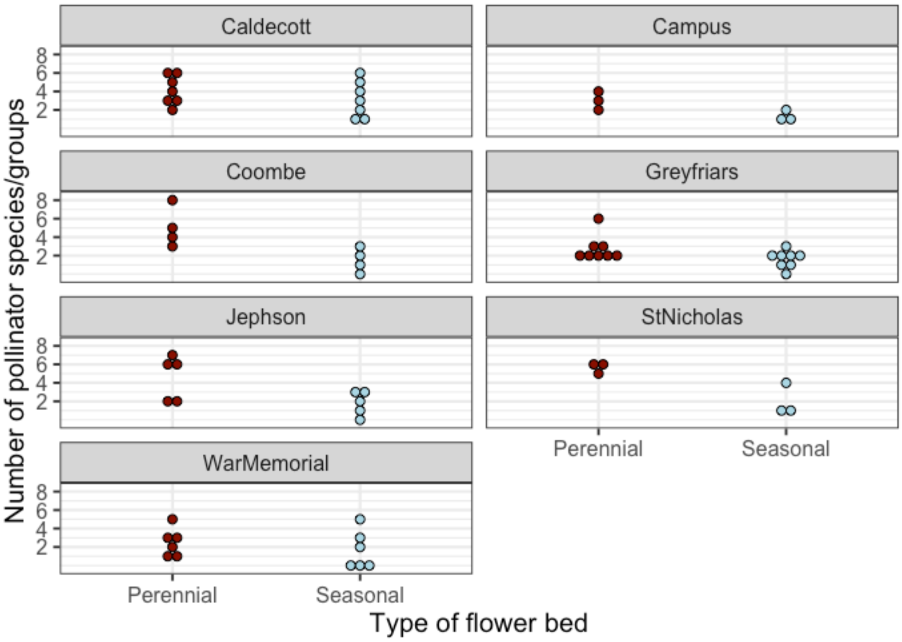


Figure 31: Dot plot of pollinator species/groups per quadrat*, total of the 3 visits, by park. Each point represents a quadrat. Horizontal jitter is applied to show points which otherwise overlap.*

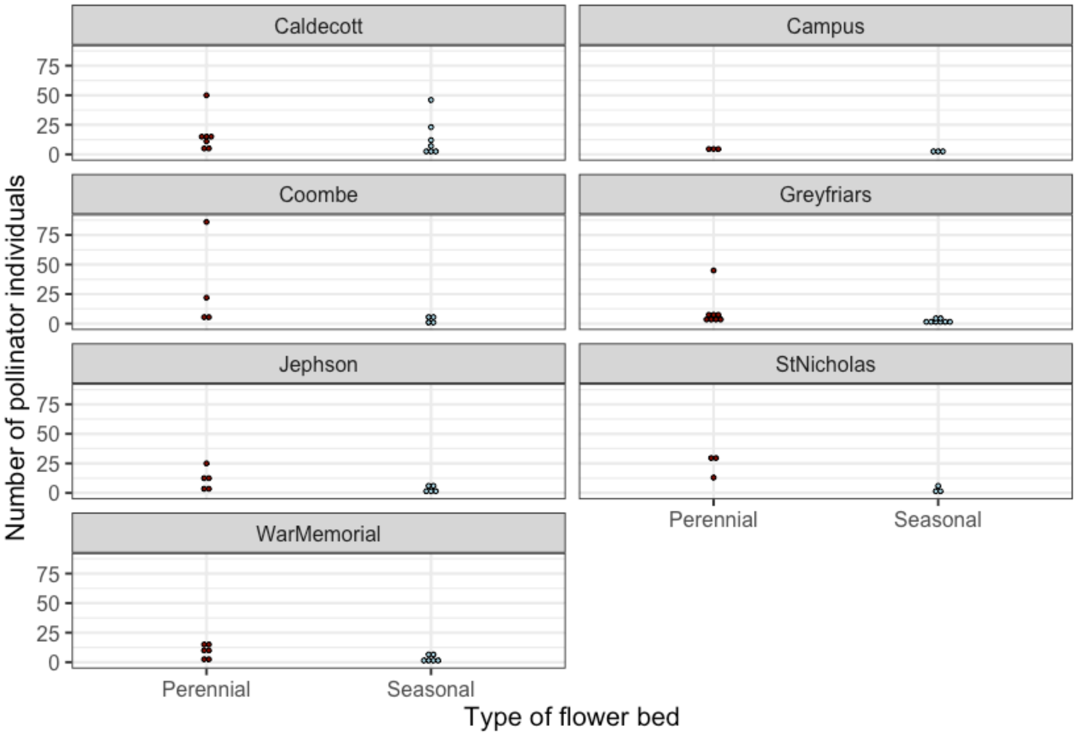


Figure 32: Dot plot of individual pollinators per quadrat, total of the 3 visits, by park. Each point represents a quadrat. Horizontal jitter is applied to show points which otherwise overlap.

Mixed effects models were built for individuals and species/groups as dependent variables, to investigate the effect of type of flower bed, with ‘park’ as a random effect and the weather variables (wind, cloud, temperature) as fixed effects. Mixed models enable the data analysis to take into account interdependence when there are grouping factors, such as ‘park’, that may not be truly independent.

Park is treated as a random effect and it is a control variable. As Park is a categorical variable with more than five levels it is suitable to be treated as a random effect (McGill, 2015). Weather (wind, temperature and cloud) are also control variables but they cannot be treated as random effects, because the measures are continuous (McGill, 2015). The weather variables were included as fixed effects (see Appendix 1.8: Species/groups by month negative binomial and Appendix 1.9: Individuals by month negative binomial).

Fewer species/groups of pollinators were observed in quadrats taken in seasonal bedding than in perennial bedding (Appendix 1.8) (coefficient estimate of -0.658 at p<0.001). This coefficient estimate is very close to the equivalent Negative Binomial General Linear Model (GLM), suggesting that the effect of the park where the quadrat is located is very small. This is also supported by the variance (0.004) and standard deviation (0.06) of the random effect which were also very small. The AIC of the mixed effect model (279.3) was higher than all of the generalised linear models (GLMs), suggesting that this model does not improve upon them.

For individual pollinators (Appendix 1.9) seasonal bedding, compared to perennial bedding, had a coefficient estimate of -1.281 at p<0.001, so fewer individuals were observed in quadrats in seasonal bedding. This coefficient estimate was a little different to the equivalent Negative Binomial GLM (-1.050), suggesting that the park in which the quadrat was located had a small effect on the number of individuals observed. The variance (0.29) and standard deviation (0.54) of the fixed effect were higher than those for the species mixed model, but they were also low indicating that the effect of site on the number of individuals was small, though greater than the effect on species/groups. The AIC of the model (460.2) was higher than some of the GLMs, suggesting that this model improves in those cases.

The mixed effect models did not produce any substantial changes in the main results when compared to the GLMs (Section 1.8.1 and 1.8.2). In general, the effect of site is small, suggesting that pseudoreplication, caused by the nesting of quadrats within sites, is not a major issue with this data set. As such the findings appear to be robust, and the assumption is that location does not impact on the inference that a greater number and species richness of pollinators visit perennial than seasonal bedding.

3.8.5 Effect of Month – date of visit

The effect of the month/date of visit was investigated to establish whether the difference between pollinators' preferences for the different types of bedding varied through the flowering season. Figures 33 and 34 show that the total number of species/groups and individuals were higher in perennial bedding quadrats during all of the visits by month. The totals were lowest in both seasonal and perennial bedding in spring/May and highest in summer/July. This might be expected because this is when pollinator activity peaks.

Separating these graphs by 'park' produces a different picture in some cases (Figure 35 and Figure 36). For example, the numbers of species/groups were higher in seasonal bedding in Greyfriars Green and War Memorial Park in September. Coombe Country Park had the highest number of species/groups in September. Caldecott Park had fewer individuals in perennial than in seasonal bedding in September.

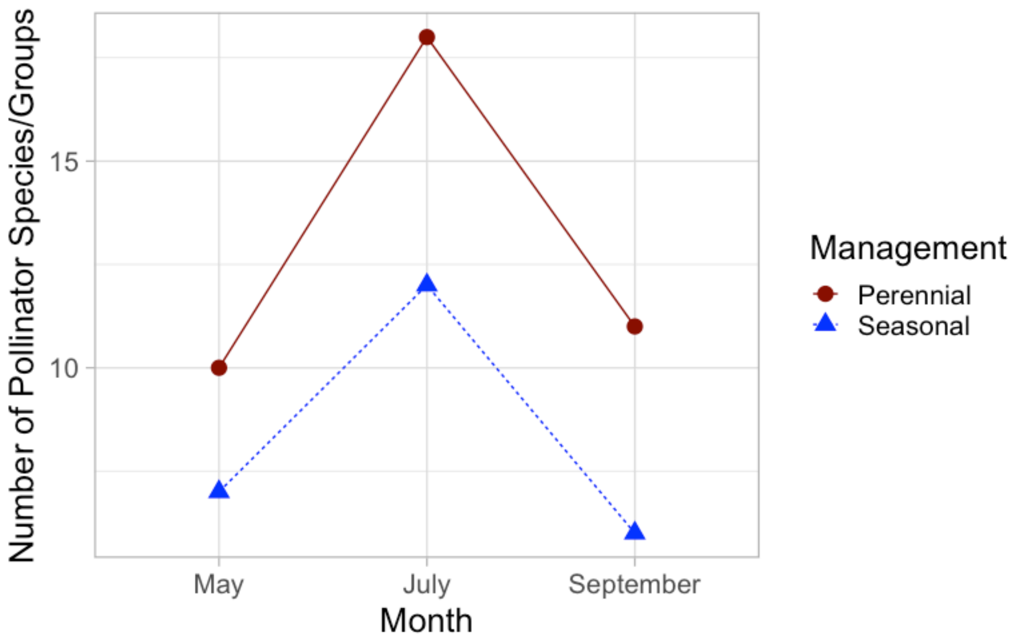


Figure 33: Total number of pollinator species/groups per month in seasonal and perennial beds.

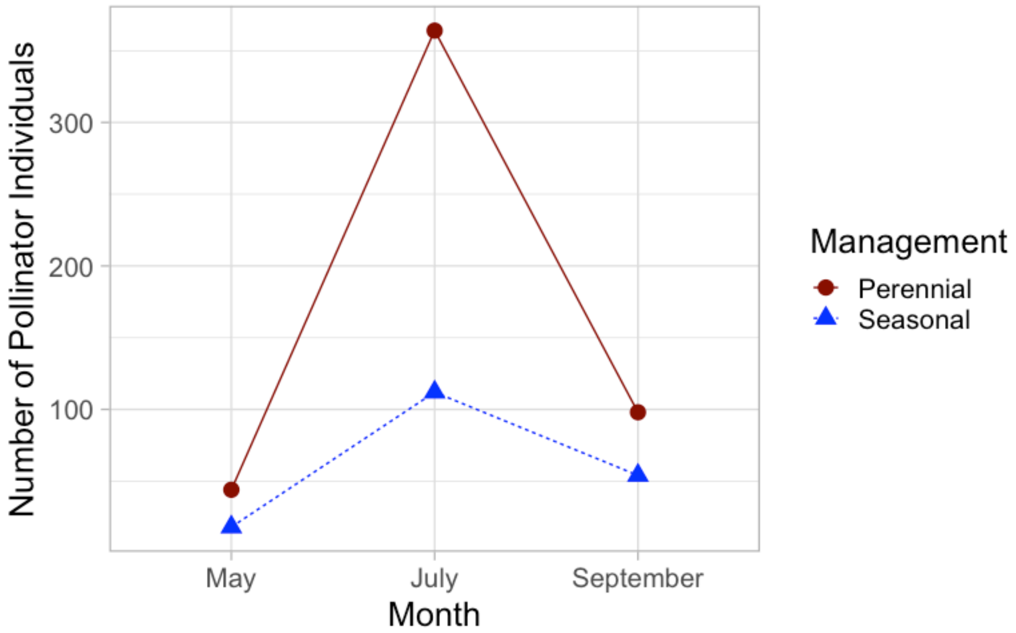


Figure 34: Total number of individual pollinators per month in seasonal and perennial beds

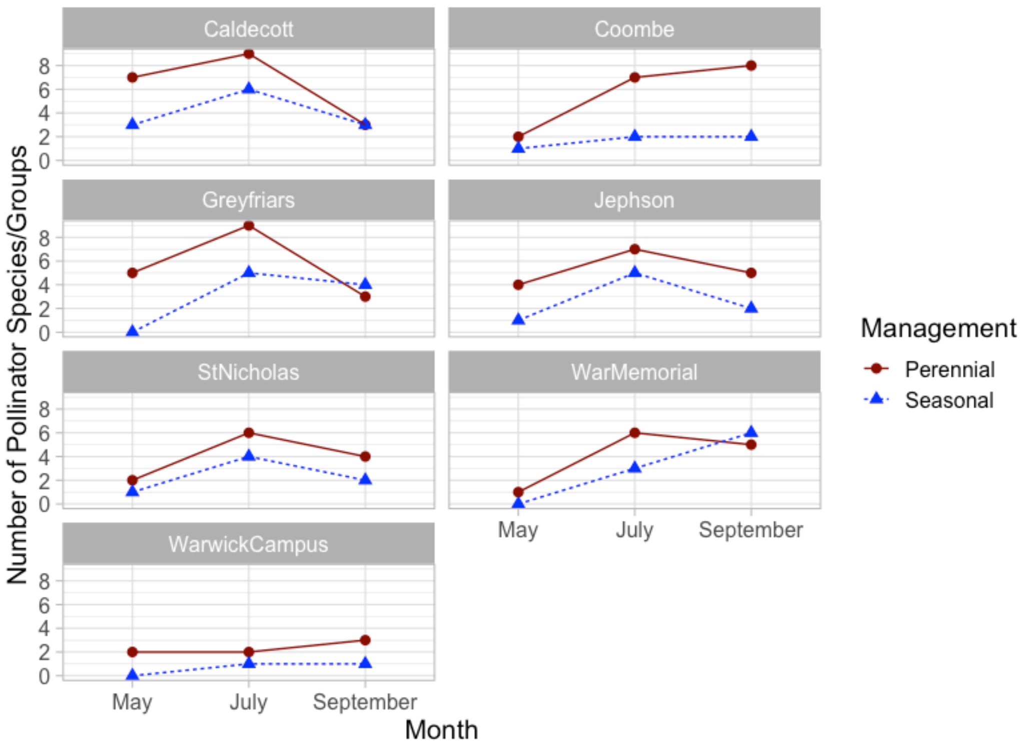


Figure 35: Total number of pollinator species/groups per month in seasonal and perennial beds, by park.

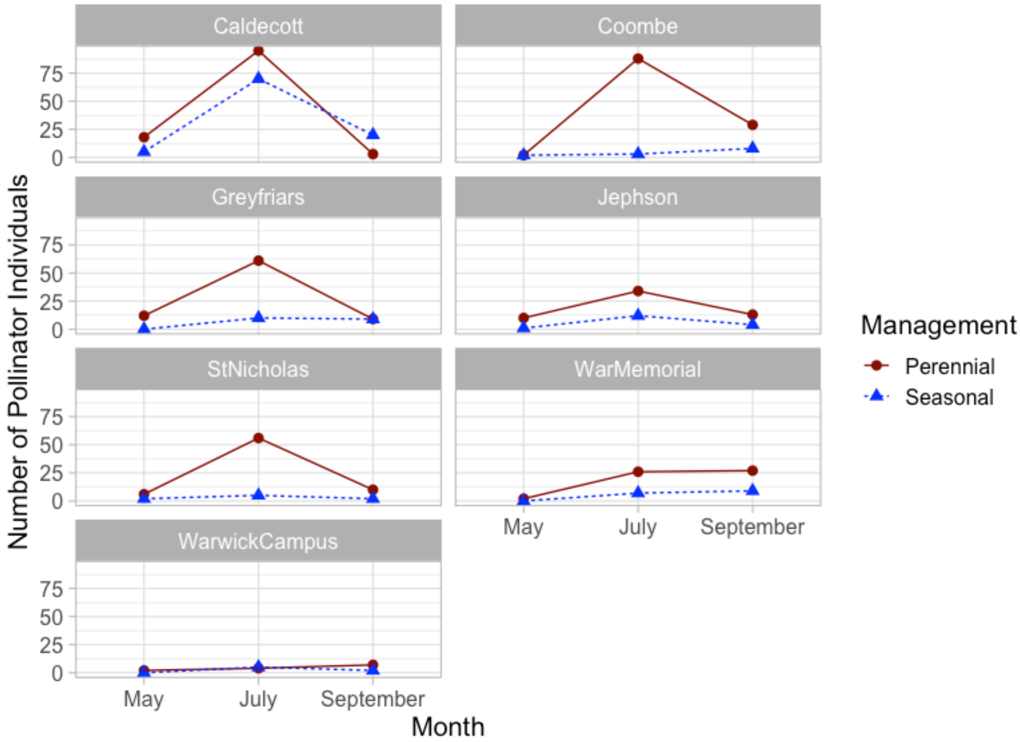


Figure 36: Total number of individual pollinators per month in seasonal and perennial beds by park.

To investigate the effect of month further, Negative Binomial models were used separately for each month. These models included 'management' and 'weather' as independent variables. Species/groups of pollinators was the dependent variable in one set of models, and another set of models had counts of individual pollinators as the dependent variable.

In May, seasonal bedding had a negative effect on the number of species/groups (coefficient estimate -1.158); this was significant at $p<0.01$. Similarly, in May, for the numbers of individual pollinators, the coefficient estimate for seasonal bedding was -1.299, at the same significance level.

In July, seasonal bedding had a negative effect on the number of species/groups in relation to perennial bedding (coefficient estimate -0.873); this was significant at $p<0.001$. The numbers of individual pollinators in July had a coefficient estimate for seasonal bedding of -1.301, at the same significance level.

For September, the results were less significant, at $p<0.05$, and the relative effect of seasonal bedding on species/groups and individuals was the smallest (-0.561 and -0.782 respectively). This indicates that the pollinators' preference for perennial bedding was highest in May and lowest in September.

Mixed models were used with month and park as random effects (Appendix 1.10). The results from use of these models show that seasonal bedding when compared to perennial bedding resulted in coefficient estimates of -0.656 for the number of species and -1.250 for the number of individuals. These were close to the 'all months' GLM results, suggesting that the effect of month was small.

3.8.6 Effect of Flower Species in Beds on Pollinator Numbers

Seasonal bedding had higher flower species richness and higher numbers of floral units per quadrat, but still had fewer pollinator species/groups and fewer individual pollinators, therefore the species richness and number of flowers did not directly predict the number of flower visits by pollinators (see Figure 37 and Figure 38).

Although individual perennial beds were less diverse, the total number of flower species in all of the beds across the whole survey season was 46 compared to just 20 in the seasonal bedding. The flowers in the perennial bedding belonged to 20 families, compared to 13 in the seasonal beds.

Detailed analyses of the numbers of pollinators on different species of flower were not carried out as the area covered by different plant species varied within the randomly chosen quadrats containing mixed species of flower. Plants in perennial beds received much higher numbers of pollinator visits per bloom than those in seasonal beds. Some examples of the numbers of insects counted visiting blooms of some of the most commonly planted flower species, across the whole 2018 survey season are given here. In seasonal beds begonias (*Begonia spp*) had 1881 floral units in total, which were visited by 18 pollinators or 0.0095 pollinator visits per flower and petunias (*Petunia spp*) with 918 floral units had 3 pollinator visits which is 0.0032 pollinator visits per flower. In perennial beds, catmint (*Nepeta spp*) had a total of 516 floral units which were visited by 57 pollinators which is 0.1104 pollinators visits per flower and lavender (*Lavandula spp*) had 581 floral units visited by 41 pollinators giving 0.0705 pollinators visits per flower.

Across the three visits, the total number of floral units in all perennial beds was just 3208, compared to 10235 in the seasonal beds. Figure 39 shows that the number of floral units in seasonal bedding is high in May, as they were recently planted, the numbers of floral units fall steeply by July, declining more gently to September. Perennial beds show a more natural pattern with a peak in the numbers of floral units in July. Figure 40 shows that the pattern in the number of floral units varies between parks, especially in the seasonal beds. This is probably due in part to variation in the timing and style of planting and re-planting.

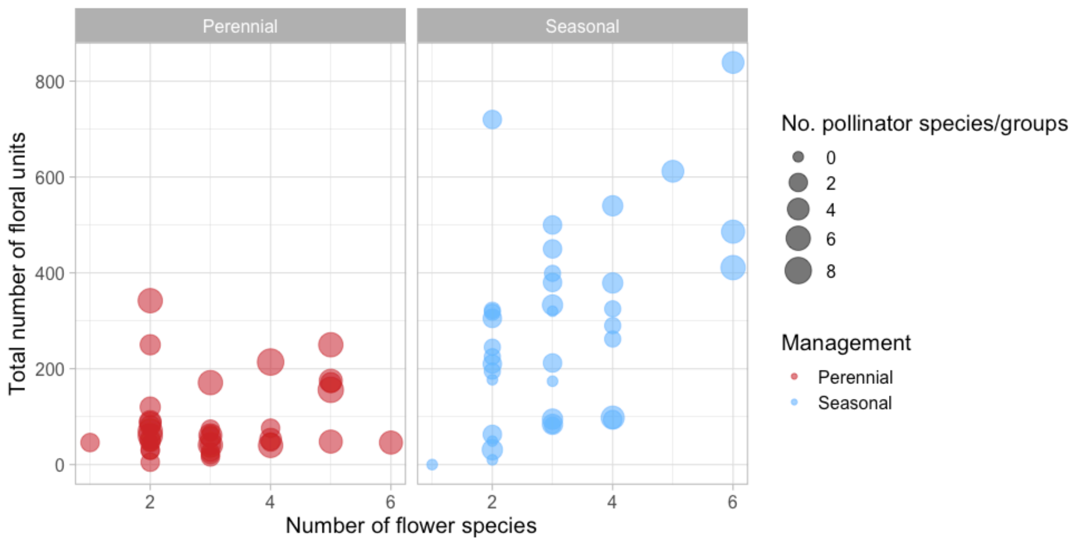


Figure 37: Bubble plot of species/groups of pollinator per quadrat by total number of floral units and number of flower species.

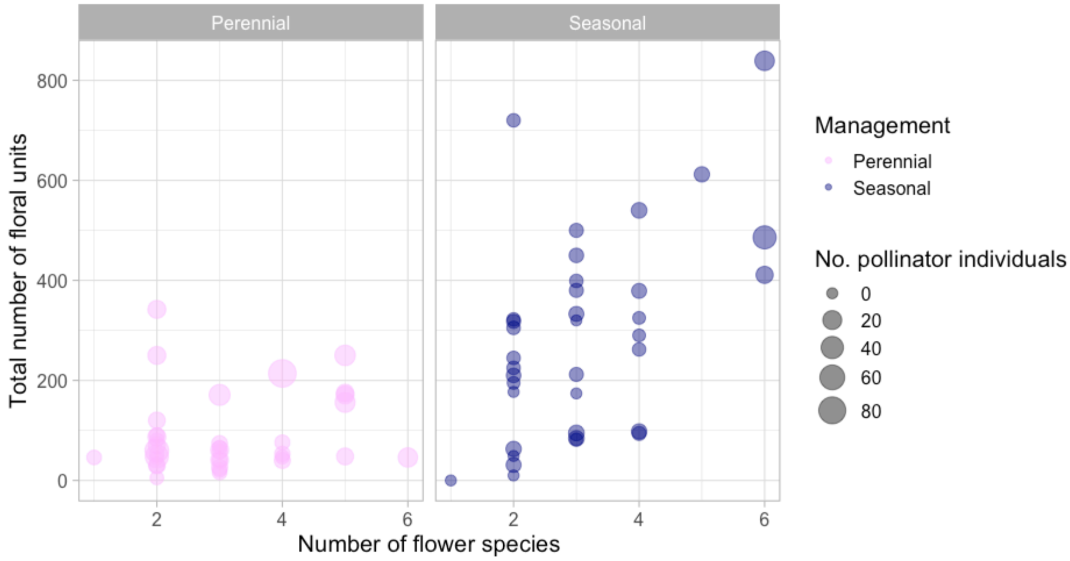


Figure 38: Bubble plot of the number of individual pollinators by the total number of floral units and the number of flower species in quadrats in perennial and seasonal beds.

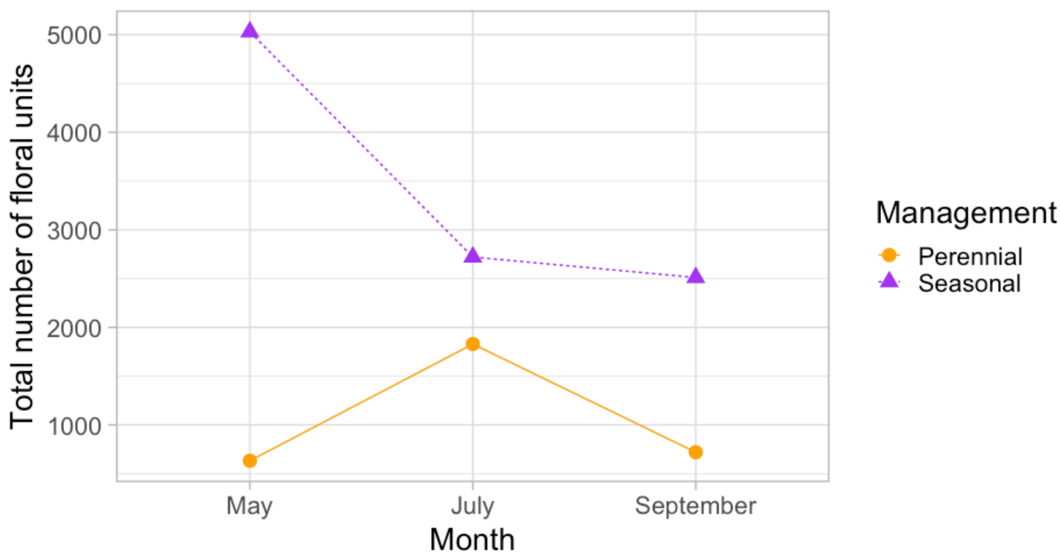


Figure 39: Total number of floral units in quadrats by month in quadrats in perennial and seasonal beds.

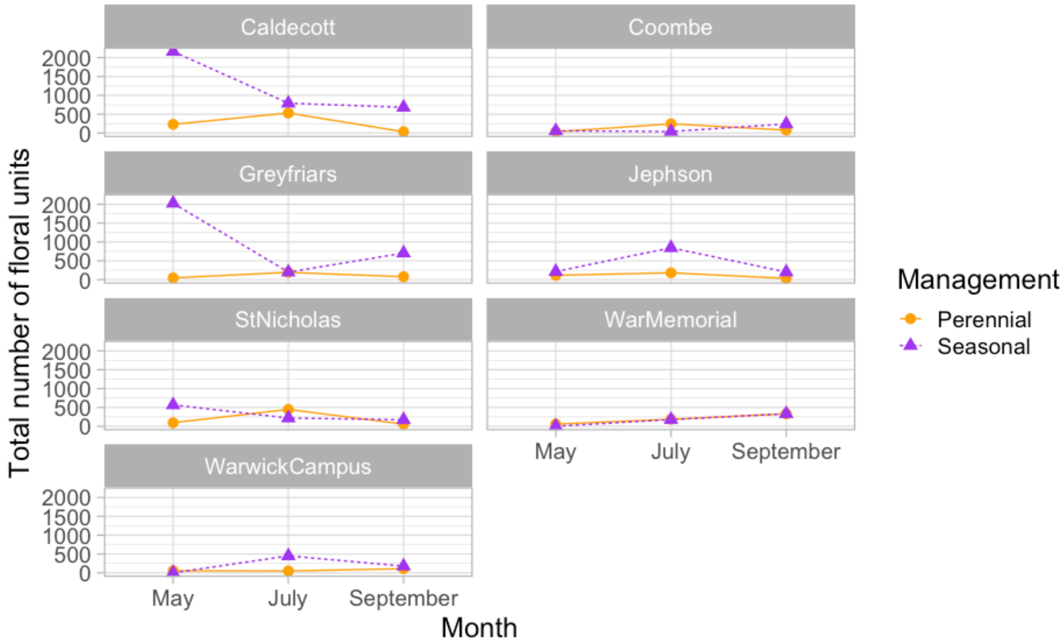


Figure 40: *Total number of floral units per quadrat in perennial and seasonal beds, by month and park.*

3.8.7 Model fit

Diagnostic plots of the residuals for the key models are included in Appendix 1.11. These demonstrate good fit of the models. For all of the Negative Binomial Generalised Linear Models (GLMs) and mixed Negative Binomial models, the residuals did not show a pattern, so there is no non-linear relationship that is not being explained by the models.

For the Negative Binomial GLMs, the diagnostic plots were satisfactory in all cases (Appendix 1.11) and therefore demonstrate that the various assumptions relied upon for the regressions, such as normal distribution of the residuals, are upheld and that the data fit the models. Quantile-Quantile plots show that the residuals were normally distributed, the majority of points being close to the reference line, with a few outliers. The Scale-Location plots have an almost horizontal line with no discernible pattern in the points, meaning that the assumption of equal variance is upheld. The Cook's Distance plots, which show the influence of any outliers on the model, had no points outside of the dotted lines, meaning that the outliers were not influential in determining the regression lines. In the Cook's Distance Plot for the model for individual pollinators two outliers were close to, or on, the Cook's Distance line, meaning that some of the outliers were close to having a marked effect on the model. If they were outside the line it would be necessary to re-run the model with those records removed. These outliers are caused by certain species in a count being represented by unusually high numbers of individuals. For example, the point labelled 51 represents a quadrat count which included 39 pollen beetles sitting on flowers. Overall, the diagnostic plots confirm that the models were a good fit for the data.

3.9 Beewalk Data

Data were kindly shared by the Bumblebee Conservation Trust from their 'Beewalk', a citizen science project in which volunteers carry out transect surveys of bumblebees. This is most comparable to the 2017 data set which was based on transects in addition to quadrats, therefore it is compared to this data.

The Beewalk survey is aimed at collecting data on bumblebees, but some surveyors include other species. In 2017, 449 sites were surveyed by Beewalk volunteers and 64 species or groups were recorded across the country (this number includes instances where the recorder was unsure of the species and gave the genus as a group).The habitat categories used in the Beewalk were based on EUNIS (the European Nature Information System) but they did not state which system of land-use classification they used. Different types of greenspace were included, for example "outdoor and amenity open spaces" and "places of worship". The habitat types did not contain enough detail to allow comparison of different types of management.

'Outdoor amenity and open spaces' had a greater median number of species and individuals per metre than many of the other land use categories (Figure 41). Allotments and cemeteries, another category which may be classed as 'greenspace', also had a good diversity and abundance of bees. These broad land-use types do not give any detail on how these areas were managed or what habitats were contained within them.

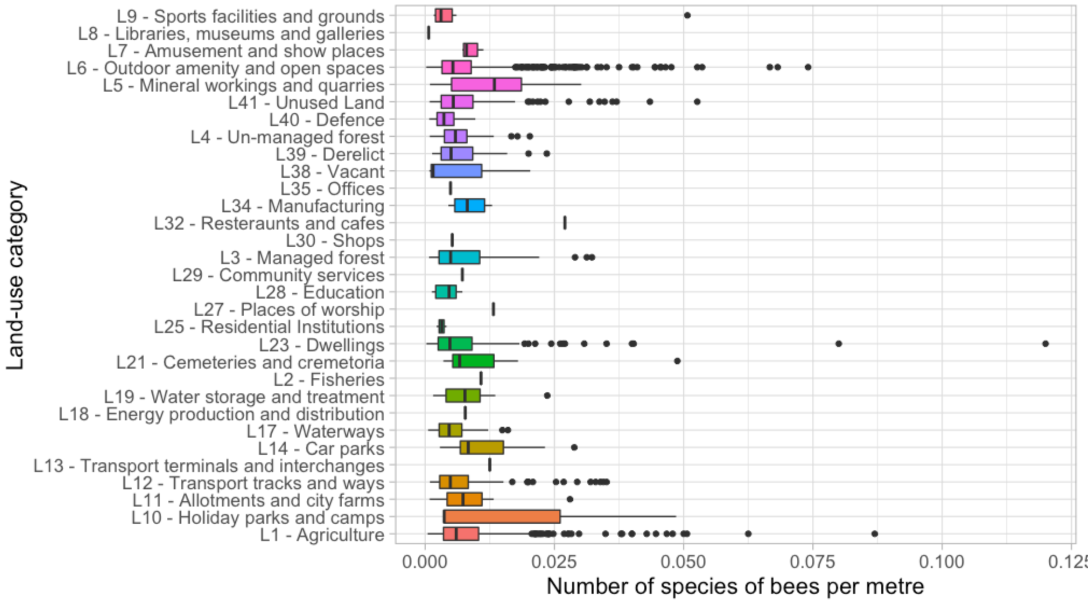


Figure 41: Number of species of bee recorded per metre of Beewalk transects in 2017 by land-use category. Data provided by Bumblebee Conservation Trust.

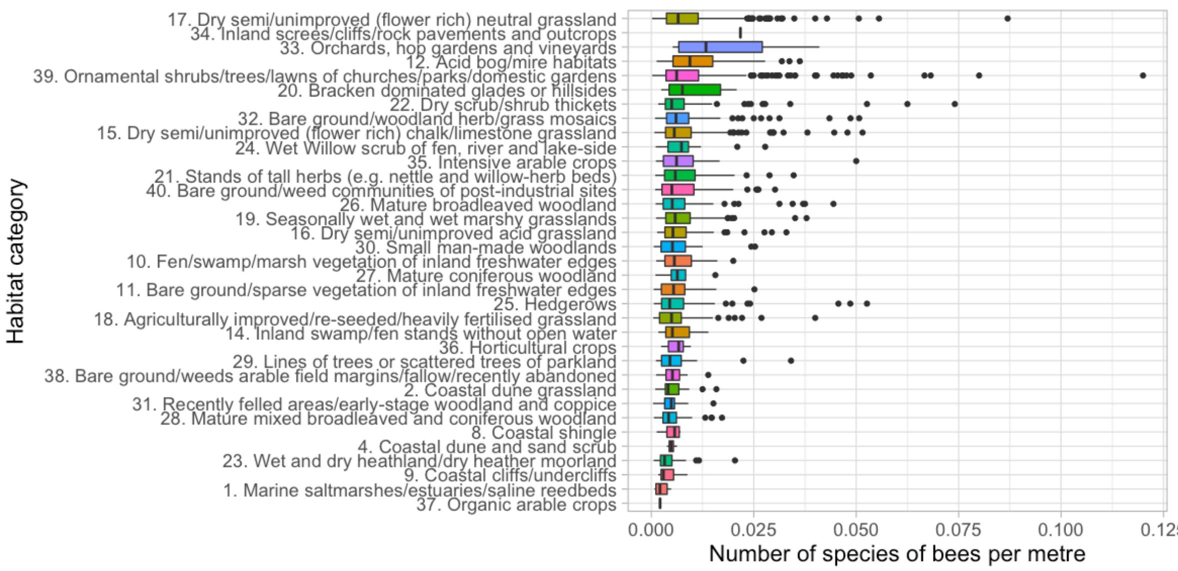


Figure 42: Number of species of bee recorded per metre of Beewalk transect in 2017 by habitat category. Data provided by Bumblebee Conservation Trust.

On the boxplots of the Beewalk data by habitat (Figure 42) ‘Ornamental shrubs/trees/lawns of churches/parks/domestic gardens’ were also in the top 8 for the median number of bee species and individuals per metre.

The surveys carried out for the present study used more specific blocks of park habitat, see Figure 43and 44. In both datasets, all habitats had a median of fewer than 0.25 individual bees per metre. For both datasets, all habitats had a median of less than 0.025 species of bee per metre, except for ‘perennial bedding’ and ‘formal garden’ in the Coventry dataset.

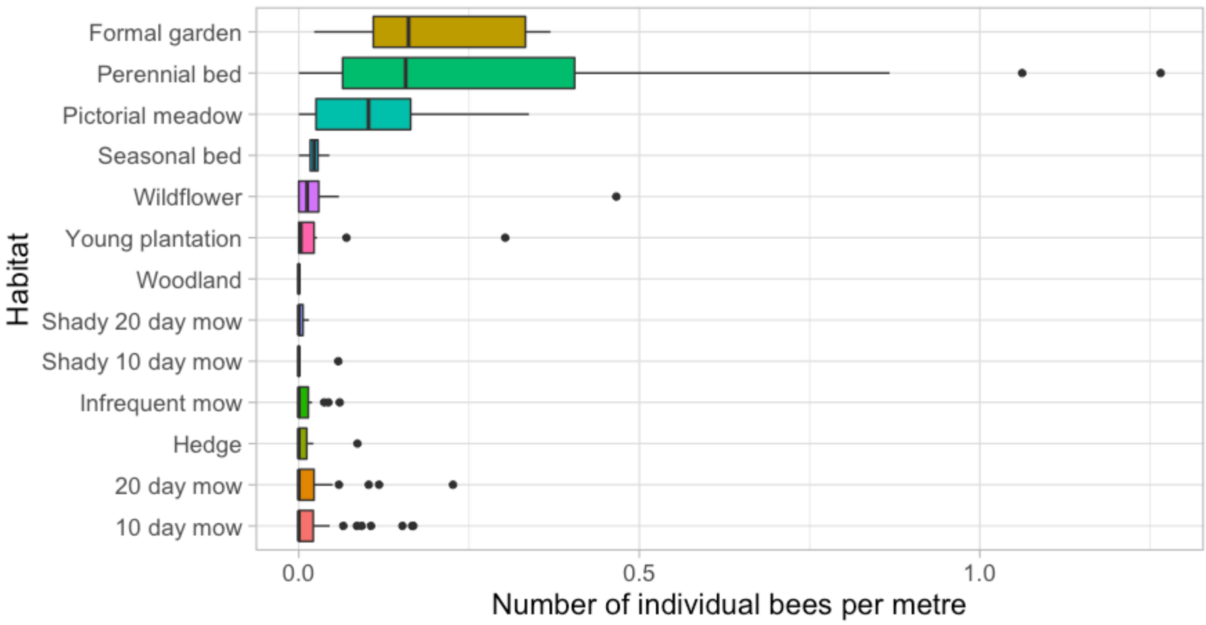


Figure 43 Number of individual bees per metre on transects in Coventry in 2017, ordered by median number of individuals.

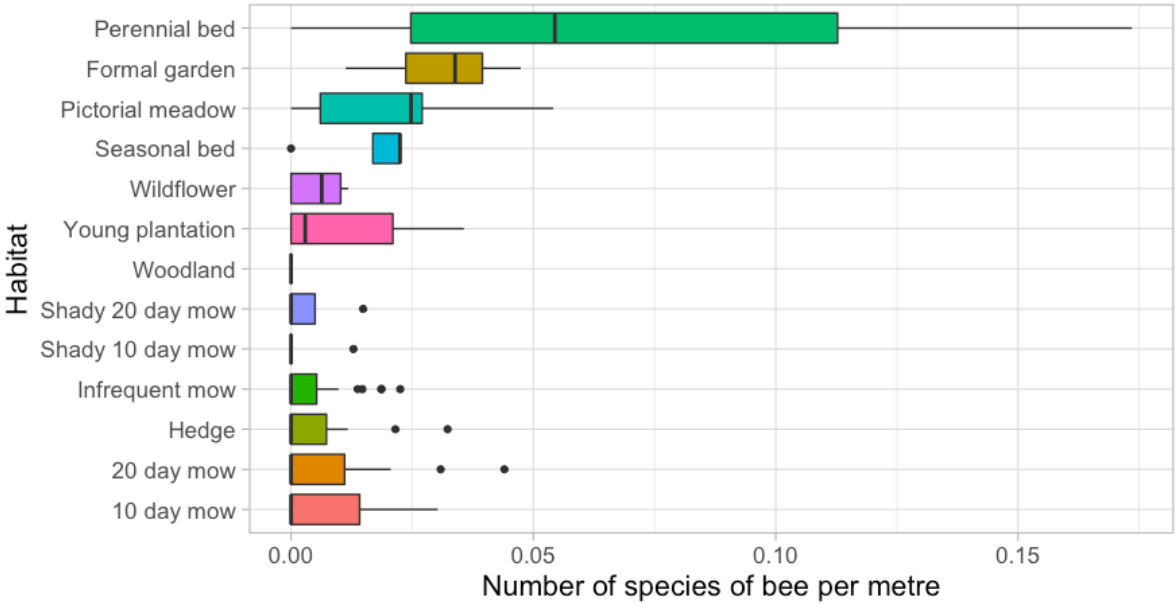


Figure 44: Number of species/groups of bee per metre in transect in Coventry in 2017 by habitat type, ordered by median number of species/groups.

3.10 "Flower-Insect Timed" Count Data

It was intended that data from a citizen science project administered by the Centre for Ecology and Hydrology (CEH) would be compared to the quadrat-based surveys carried out as part of this project. The Flower-Insect Timed Count (FiT) consisted of timed counts of insects visiting target flower species, similar to the quadrats used in the present study. CEH were willing to share the data but, at the time of writing, the data were not available.

Some headline data were available online for the 2018 survey season. CEH received 584 counts, from 110 recorders and 44% of these were from private gardens and most of those conducted in the countryside were from hedgerows or grassy verges. Over 5,300 insects were counted; a mean of 9.2 individuals were counted on target flowers per ten-minute count. Like the present study, the majority of the insects counted were "bumblebees, hoverflies, other flies and small insects." (Carvell and Roy, 2019).

The data, if they had been available, would not have been directly comparable as the FIT counts were based on a 50 cm x 50 cm quadrat, a 10 minute count and a specific flower species, compared to the 2 m x 2 m quadrat, a 5 minute count and mixed flower species used in the present study.

The counts in the present study gave a total of 514 individual pollinators in quadrats from perennial bedding over the whole season, this means a mean of 171.33 per sampling visit as each quadrat received 3 visits. A total of 176 individuals were seen overall in the quadrats from seasonal bedding, 58.66 per visit. The CEH counts were twice as long but the quadrat was 16 times smaller, so a count of approximately 8 times the number of individuals might be expected here. The FIT counts scaled in this manner (9.2 x 8) would give a mean of 73.6 individuals which this is higher than the counts reported in the present study for seasonal bedding (58.66) but lower than those for perennial bedding (171.33). This suggests that perennial bedding attracted more pollinators than the habitats surveyed in the FIT counts, and that seasonal bedding attracted fewer pollinators than in the FIT counts. As further detail on the habitats surveyed and the counts from individual quadrats was not available at the time of writing, no further conclusions can be drawn. However, as the numbers of pollinators are broadly comparable between the two methods this helps to validate the techniques used here.

3.11 Discussion

This chapter aimed to assess the preference of insect pollinators for different floral display types in urban greenspace. This can inform park managers in planning cost-effective and attractive displays that also attract pollinators. The study focused on two types of planting, perennial and seasonal bedding. The change from seasonal to perennial bedding is a key management choice made by parks officers, often in an attempt to make budgetary savings. After an initial round of fieldwork on a wider range of habitats (in 2017), a narrower focus on seasonal and perennial bedding in 2018 aided collection of data which allowed a robust analysis.

3.11.1 Result summary

Seasonal and perennial bedding displays differ in the method of management, whether they are replanted regularly or not, and also in the varieties of plants which are commonly used. Overall, seasonal bedding had greater numbers of flowers and greater floral diversity within surveyed quadrats, although perennial bedding had a greater species diversity across the whole dataset.

In 2018, the perennial bedding displays had a greater number of both species/groups and individual pollinators. This can be seen in Figure 27 and 28, and is supported by the results of the analysis (Appendices 1.3 and 1.4). This pattern is also true for bumblebees as a subset of the data (Figure 29 and Figure 30, Appendix 1.5). Mixed models (Appendix 1.8 and 1.9), controlling for the effect of ‘park’, also support this result.

Greater floral diversity in seasonal beds did not coincide with a greater abundance or species richness of pollinators. This suggests that it was the quality and not the quantity of flowers that influenced pollinator choice. Corbet *et al.* (2001) found that exotic flowers and double cultivars (with extra petals) were less attractive to pollinators. These are common in seasonal beds, for example, double varieties of petunia. Another possible reason for lower pollinator numbers could be disturbance, for example ground nesting bees may nest in bare soil in beds, and nests could be destroyed when seasonal bedding is replanted.

For War Memorial Park and Greyfriars Green, the number of species/groups was higher in seasonal than perennial bedding in September and in Caldecott Park fewer individuals pollinator were found in perennial than seasonal bedding in September. In all other parks/months, abundance and species richness were either equal or greater in perennial bedding (Figure 35 and Figure 36). War Memorial Park, Greyfriars Green and Caldecott Park all had low numbers of floral units in perennial bedding in September, which may explain this effect (Figure 40). Some of the other sites also had low numbers of floral units in perennial bedding in September without the numbers of pollinators falling below those in seasonal bedding. Most of the sites, excluding The University of Warwick Campus and War Memorial Park, which both had higher floral units in September than in July, had a peak in floral units in their perennial beds in July and low numbers of blooms in September. Pollinators' preference for perennial bedding is highest in May and lowest in September, probably related to the decline in bloom numbers in perennial beds.

The data shared by the Bumblebee Conservation Trust from their Beewalk project, and headline data from the Centre for Ecology and Hydrology's Flower-Insect Timed Count (both UK wide), showed similar numbers of pollinators to the current study, suggesting that the results may be transferable to other areas of the UK. The Beewalk data showed that higher abundance and species richness of bees were associated with amenity and ornamental spaces when compared with many other habitats/land-use. Other naturalistic habitats often associated with public open space harboured fewer pollinators. Such as woodland, this can be explained, woodlands are shady and therefore often less flower-rich than other habitats. Hedges can be flower-rich, but usually mainly in spring. Many hedgerow species, such as hawthorn and blackthorn, flower early in the year. This means that although they can provide a valuable early pollen and nectar resource when pollinators are waking from hibernation, if measured across the whole survey season the numbers of flowers and counts of pollinators appear lower than other habitats.

Honey bees (*Apis mellifera*) were one of the most numerous species seen in both years of this study. The honey bee is a domesticated species which is not native to the UK and it competes with native bees for pollen and nectar resources. The numbers of honey bees have been shown to be negatively correlated with the numbers of wild bee species (Ropars et al., 2019; Henry and Rodet, 2018; Torné-Noguera et al., 2016). It has also been pointed out that the media tend to focus on honey bees at the expense of wild bees (Geldmann and González-Varo, 2018; Smith and Saunders, 2016). This focus on honey bees can draw focus and public support away from conservation of wild pollinators. Diversity of pollinators is important as this increases resilience.

3.11.2 Critique of methods and suggestions for further work

It was not possible to demonstrate the effect of mowing regimes using the 2017 transect data. This was partly due to the timing of mowing which varied due to weather conditions, and other factors such as availability of greenspace maintenance staff. This meant that, for example, one could be visiting a 20-day mowing interval transect the day after it was mown, and a 10-day mown transect 10 days after it is mown. To further investigate the effect of mowing it would be necessary to either set up test plots to be mown on an exact schedule or to work more closely with a local authority to be informed of the exact time of mowing, which has the advantage of testing the difference in the real setting of a park.

Quadrats contained a mixture of species of flowering plant with different areas of each species. This variation did not allow detailed analysis of the attractiveness of different varieties of flowers to pollinators. Planting standardised trial plots of species of particular interest and counting pollinator visits could be a method to investigate this aspect further. Various studies (e.g. Garbuzov and Ratnieks, 2014; Salisbury *et al.*, 2015) have taken this approach and might act as a model for a new study of perennial and seasonal bedding.

Because of the refocussing of the study between the 2017 and 2018 survey seasons, multiple years of comparable data were not available. As pollinator populations fluctuate greatly from year to year, an ideal study would last for many years to allow for these natural fluctuations (Roubik cited in Food and Agriculture Organization of the United Nations, 2008). Only a short time period was available for this study, so flower beds where management has changed were compared to beds where management has not changed. This provided a method to compare 'new' and 'old' management. This approach had the important advantage that annual variations and the effects of climate were kept to a minimum. If a longer timeframe were available, the effect of management could be measured 'before' and 'after' the changes. However, it is not possible to compare two years in this way, even without the change in focus and locations in this study. This would require sampling being undertaken over several years and using many sites to allow for natural fluctuations in pollinator populations and local variations, for example, other management approaches or changes in the use of neighbouring land.

Further study could include using sites over a wider geographical area to ensure that results are transferable to other areas of the UK. Sites could be sought with a wider range of habitats within the greenspace to allow comparison of a wider range of floral display. For example, as a relatively new planting regime in greenspaces, Pictorial Meadows are of interest, and human preferences for these were investigated in Chapter 5, but only two of the greenspaces used here include areas of Pictorial Meadows, as well as perennial bedding and seasonal bedding.

This study aimed to investigate ‘real-world’ examples of changed maintenance in greenspaces. Another approach would be to plant experimental beds, which may give greater control over the types of flowers used but may not accurately replicate how they are planted and managed in greenspaces, or the pollinator assemblages living in these areas.

Whilst the current study used case studies in greenspaces in the West Midlands, the results are likely to be transferrable to other regions. Further study could include repeating the experiments in other areas. The data from the Beewalk and FiT Counts suggest that the number of pollinators counted in this study were comparable to other UK data but a study of wider geographical area could confirm this. A wider study could also allow the comparison of a greater variety of habitats and management regimes.

Data from 2017 was not analysed in detail due to the varied number of replicates. This required the refocussing of the study in 2018 to a just two management types. Given more time and a greater number of observers it would be interesting to collect data from a much wider range of management styles.

Although overall perennial bedding attracted greater numbers and species richness of pollinators, some seasonal bedding quadrats attracted more insects than some perennial quadrats. Further study could investigate the drivers for this. Is it due to qualities of the plants in the individual quadrats or other factors such as the surrounding habitat? This could inform park managers who wish to continue with traditional management about the most pollinator friendly ways to do so.

This study compared the preference of pollinators through their distribution within a site. Allowance was made for the effect of habitat by scoring the parks and by allowing for the effects of the location in the analysis. Further investigation of the total abundance and diversity within a greenspace and how this relates to this internal distribution could add to the understanding of the effects of management on pollination.

Further study could include the application of indices of diversity to the groups which were recorded predominantly to species level (for example bumblebees). This would allow comparison of diversity between the habitat types. However, this requires applying the assumption that a pseudo-species can be treated as a species (for example the *Bombus terrestris* and *Bombus lucorum* aggregate used here). Higher taxonomic ranks, such as genus, could be used but this can introduce errors (Wu, 1982; Bringloe *et al*. 2016).

3.11.3 Recommendations to park managers

Based on these results, perennial bedding is preferable to seasonal bedding for pollinators. However, park managers should select plants for perennial bedding which ensure that flowers are available in the 'hungry' periods in spring and autumn. They should also ensure that, if they continue to use seasonal bedding, it is replanted promptly to ensure continuity in the floral resource. If all seasonal bedding is replaced with perennial bedding, which does not provide blooms in late summer/autumn this could have a negative impact on pollinators. On the University of Warwick Campus, the plants providing late-flowering blooms included catmint (*Nepeta spp*.) and *Verbena bonariensis*, in Memorial Park they included *Verbena bonariensis*, lavenders (*Lavandula* spp.) and ice plant (*Hylotelephium spectabile*). These plants are all well-used by pollinators and could be amongst the options to include in perennial bedding to ensure late floral resources are provided.

It was noted during surveys that bumblebees were seen foraging on clover (*Trifolium spp)* even in a relatively short sward. This suggests that even a moderate reduction in mowing could benefit pollinators by allowing the floral resource to persist for longer. For larger parks, mowing certain areas on a different schedule could also help ensure continuity of pollen and nectar resources. Larson, Kesheimer and Potter (2014) found that dandelion (*Taraxacum officinale*) and white clover (*Trifolium repens*) in lawns attracted a range of pollinators, including some uncommon bumblebees. Plantlife (2019) compared flowers in lawns and found that white clover followed by dandelion provided the most nectar, though daisies were the most numerous. In another article, Plantlife (2020) suggest that home gardeners will provide up to ten times more nectar for pollinators by reducing mowing to once per month in the summer. A similar benefit could be generated by reducing mowing in urban greenspaces.

3.12 Conclusion

The data suggest that pollinators prefer perennial bedding to seasonal bedding, in parks in the West Midlands. Perennial bedding was visited by both a greater number and a greater richness of species of insect pollinators at all of the seven study sites.

As the adoption of perennial bedding has been a cost-saving exercise in many parks, these results suggest that park managers can both save money and better support pollinators, which will also support the ecosystem services which they provide, and the ecosystems to which they belong. However, changes need to be managed with care to ensure that floral resources are available to pollinators throughout the season, particularly in late summer.

4 SCENICNESS OF GREENSPACES BY TYPE

4.1 Background/Introduction

This chapter investigates the types of park or greenspace that human visitors prefer through the "scenicness" or attractiveness of these places using data from the whole of Britain. This links to the previous chapter, which investigated the preferences of pollinators. Whether humans enjoy naturalistic landscapes has an impact upon whether other ecosystem services such as pollination can be easily accommodated in urban greenspace, where amenity can be the dominant consideration when planning management. Human preferences were investigated at a finer scale in the following chapter.

Parks and other greenspaces contribute to the amenity (the useful and/or enjoyable features) of urban areas. 'Scenicness' is a term used to describe people's perceptions of how attractive landscapes are, and can be considered as one element of this amenity value as a measure of greenspace users' visual enjoyment. Scenicness is a way of describing people's landscape preferences and is "the basis for expressing environmental preferences … in recreational and residential circumstances" (Amedeo, 1999). Scenicness contributes to cultural ecosystem services, or it can be considered an ecosystem service in its own right. Martínez-Harms and Balvanera (2012) state that ecosystem services that are important for human welfare, including scenic beauty "are rarely addressed." The Monitor of Engagement with the Natural Environment survey (Natural England, 2018) found that 25% of urban park visits and 43% of playing field or recreation area visits in England were motivated by wishing to "enjoy scenery" and, while this may not be the primary motivation for all visitors, the scenery, good or bad, will still have an impact upon their visit.

There is a lack of guidance for greenspace managers on how to maintain their sites or what makes them attractive to users. Roberts-Hughes (2013) found that the two factors that would most encourage people to walk more were "safer design of pathways" and "more attractive public parks and green spaces". Similarly, Van Herzele and Wiedemann (2003) state that the "availability of accessible and attractive green spaces is an integral part of urban quality of life." What makes a greenspace attractive, and how can managers improve the scenicness of their sites?

Aesthetic beauty of landscapes has been assessed by a range of approaches, often employing a questionnaire and/or the rating of photographs (Blasco et al., 2009; Du et al., 2016; Akbar,Hale and Headley, 2003). Some authors question the validity of photo-based assessments as viewing images may differ from experiencing a landscape in person. For example, Gyllin and Grahn (2015) were not able to demonstrate that on-site and photograph based experiences are directly comparable. Hull and Stewart (1992) advised caution in the use of photograph-based surveys as they found that some respondents' on-site ratings differed from their ratings of photographs, possibly due to differences in the experience of visiting in person. However, Hull and Stewart (1991) state that "average on-site scenic beauty ratings were similar to the average photo-based ratings." They also found, via a 6-month retest, that "individual's photo-based assessments appear reliable and stable" (Hull and Stewart 1992). When used carefully, photo based assessments can provide useful information on landscape preference.

There is a range of literature relating to the scenicness of landscapes in general but there is limited understanding of how different styles of management affect people's enjoyment of urban greenspaces. This study investigates preferences for different types of greenspaces and styles of management of these areas to better understand how these factors affect people's visual enjoyment and, therefore, contribute to the amenity of these spaces.

The term ‘greenspace’ is used here to refer to publicly accessible green open spaces including cemeteries, canals, sports grounds etc. ‘Parks’ are a sub-category of greenspace which tend to be more formal. For example, parks often feature closely mown grass and flower beds.

The hypothesis is that different types of greenspace will have different perceived scenicness. Which types of greenspace are considered the most scenic? Biodiverse greenspaces such as local nature reserves? Or ‘manicured’ greenspaces such as formal parks? The scenicness of different types of greenspace is investigated to assess the potential effects of more naturalistic management on this aspect of amenity.

To assess the relationship between the type of greenspace (formal or natural) and scenicness, crowd-sourced ratings of the scenicness of images from the website “Scenic-or-Not” (Data Science Lab, 2017), were compared to types of greenspace using the Ordnance Survey’s national map of greenspace, as well as older greenspace maps of London and Scotland.

This study builds on the work on pollinators in the previous chapter by investigating whether naturalistic management, which can be better for wildlife (see chapter 3), is also preferred by human visitors. People’s preferences were investigated in greater detail in the following chapter.

4.1.1 Study question/aim

Do people prefer formal or naturalistic parks and greenspaces? Which of these are considered more scenic?

This study aims to inform park managers on the greenspace users’ preferred styles of management. A move to naturalistic management could potentially improve greenspaces for wildlife and help to make budget savings.

Other factors which could be driving the scenicness of the greenspace images were also investigated. The location and whether the greenspace is located in a major town or city were examined. The size of the greenspace in relation to its scenicness was measured, as there is pressure on land in urban areas this relationship is of interest, is it important to maintain larger greenspaces?

4.1.2 Objectives

This study contributes to the following objectives (as set out in the thesis introduction):

RO4. Investigate the effects of management practices on amenity
RO5. Investigate possible trade-offs between management practices that support biodiversity and other aspects of amenity.

4.2 Literature (related work)

This section examines the existing literature related to landscape preference, in particular in relation to naturalness in urban greenspace. Also included is a summary studies which have used the Scenic-or-Not dataset which is used in this chapter and how the current study builds on this existing work.

In Sheffield, Özgüner and Kendle (2006) found that "[t]he public can distinguish between naturalistic and more obviously designed landscapes" and that they appreciate both, and gain some of the same benefits in both, as well as differing benefits between the two. Özgüner and Kendle (2006) also found that *some* greenspace users do not enjoy more natural landscapes as they "find them untidy, ugly, or in some way a compromise of civilised aesthetic values" (Özgüner and Kendle, 2006). Conversely, van der Jagt *et al.* (2014) demonstrated that "naturalness is a powerful and positive predictor of scenic quality."

In four European case study cities, Bertram and Rehdanz (2015) found that respondents felt neatness was more important than naturalness, followed by spaciousness and finally sociability. Respondents stated that recreational value was more important than regulating ecosystem services and aesthetic appreciation. However, it might not be possible to separate recreation from aesthetics as enjoyment of a recreational activity will be impacted upon by the scenery. Bertram and Rehdanz's (2015) study asked respondents specifically about ‘parks’ which tend to be relatively formal places, but other urban greenspaces such as woodland, nature reserves or cemeteries, are likely to have been expected by the respondents to have different qualities. Another study of people’s preference in public parks found that maintenance and cleanliness was the prime factor (Madureira *et al.* 2018), although aesthetics was not explicitly investigated in this study. Madureira’s study uses the term ‘park’ and the term ‘public green space’ interchangeably, it is not clear how the questions were put to the respondents, which could have an effect on the result.

The studies described in the previous paragraphs give a mixed picture on the public’s appreciation of natural vs neat landscapes and this is an area where further research is required. The studies above used photo based surveys or face to face surveys to collect people’s landscape preferences. Another method for acquiring data on people’s preferences is the use of crowdsourced data. This has advantages, including the ability to acquire large scale datasets quickly and with minimal resources. There are also disadvantages to using crowdsourced methods including lack of information about the respondents and selection biases such as only including users of a particular platform (Bubalo,Van Zanten and Verburg, 2019). This chapter uses crowdsourced data from the website Scenic-or-Not (Data Science Lab, 2017) where users rate photos taken in Britain to investigate preferences for naturalistic or formal landscapes. The dataset is described in greater detail in the Methods section of this chapter. As this is a relatively large dataset (containing 217674 images rated 3 or more times), with images across Britain, it provides a good starting point for research into people’s preferences in parks, which complements the more focussed study reported in chapter 5.

The following studies have also made use of the Scenic-or-Not dataset. Seresinhe *et al*. (2015) used crowdsourced ratings of scenicness from Scenic-or-Not to demonstrate that people living in more scenic areas reported better health on the UK census than those in less scenic areas. Seresinhe *et al*. (2015) also investigate various factors, other than scenicness, which impact upon health, including air pollution and socio-economic deprivation. The authors also examined the effect of colour on the scenicness of images. By assigning the pixels in the images to 11 principal colours, they found that scenic images contain large amounts of grey, brown and blue pixels, as well as the expected green, and suggest that these may be water or mountain features. Some images contained a large amount of green but received a low scenicness score, which could be caused by other features in the image such as buildings, or that they consist of bland expanses of flat grass. Scenicness increased slightly with colour saturation, though there were not simple relationships between scenicness and the warmth of colours nor with their brightness. This work was extended using a deep learning approach (Seresinhe *et al*. 2017) that used the Places Convolutional Neural Network (CNN) to categorise the features of photographs rated in Scenic-or-Not and then train the neural network to recognise scenic images. In another study, Scenic-or-Not data was used to validate Seresinhe *et al.*'s (2018) estimates of scenicness from other crowdsourced platforms, Flickr and OpenStreetMap. Scenic-or-Not data were also combined with data from a smartphone map called ‘Mappiness’ which asks users to rate their happiness at random points through the day, the research relates this to the percentage greenspace of the LSOA (Lower Level Super Output Area) (Seresinhe *et al.* 2019). LSOAs are a geospatial reporting unit used in England and Wales, each containing a mean population of 1500 or 650 households. Seresinhe *et al.* found a correlation between happiness and scenic locations. Their measure of ‘greenspace’ is based on percentage of green landcover (the Generalised Land Use Database

Statistics for England 2005) and, therefore, includes private gardens and grounds. These areas are not generally accessible to the general public and therefore have limited amenity for the wider public unless they are sufficiently visible that they can improve the view.

In another study which used the Scenic-or-Not dataset, Workman *et al*. (2017) use Scenic-or-Not to test the results given by their CNN. They found that man-made features were dominant in the images with low scores, and natural features dominate the images considered to be scenic. A spatial model of scenicness in Britain was created by Chesnokova *et al*. (2017) using the Scenic-or-Not dataset and the descriptions of the images from Geograph.

Tidiness and maintenance were key themes in the above studies which investigated aesthetic enjoyment of spaces. Naturalness has also been demonstrated to be a predicator of scenicness. The studies described above which used the Scenic-or-Not dataset investigated general questions about the scenicness of images. This provides some interesting information about landscape preferences in general, but it does not allow the comparison of different types of urban greenspace. The current study differs in that it measures the scenicness of only publicly accessible greenspace, which can be enjoyed by anyone. This study uses a subset of the Scenic-or-Not dataset based on the images taken in publicly accessible greenspaces, spatially matched with maps of publicly accessible greenspace. This study can then answer the more specific question of: which categories of park or greenspace are considered to be most scenic? The research can then inform park managers or designers on people’s preferences to allow the design and management of aesthetically pleasing greenspaces.

4.3 Methods

This study is focused on an analysis of data from 'Scenic-or-Not' and the Ordnance Survey (OS) Greenspace map (Ordnance Survey 2017). The OS Greenspace map is the first national map of Great Britain's public parks and open spaces. The national map was released in 2017. London's map (Greenspace Information for Greater London, 2016) is available on request under license, and is free for the purposes of academic study. Scotland's map (Greenspace Scotland, 2011) is only available with a paid Ordnance Survey subscription. Both the London and Scotland Greenspace maps have been available since 2011. A pilot study investigated data for these two areas prior to the release of the national map. These provide greater detail on the type of greenspace than the national map.

Scenic-or-Not (scenicornot.datasciencelab.co.uk) (Data Science Lab, 2017), which is hosted by the Data Science Lab, Warwick Business School, and contains crowdsourced ratings of the scenicness of geotagged images. The website claims to take the form of a "game" where users rate a random image, awarding a score of 1-10. Only then are they told the current average rating of the image based on all users' scores, and its location. The FAQ on the website state "it's a game - pit your aesthetic judgements against other users, and discover the lovely and not so lovely corners of Great Britain" (Scenic-or-Not 2017).

Any image with more than three scores given by users of Scenic-or-Not is included in the dataset, which is downloadable from the website. The images originate from Geograph (geograph.org.uk), a project which aims to publish representative images for all 1km grid-squares across the UK. The photographs are submitted by volunteers.

Sub sets of the Scenic-or-Not scored images were created by spatially matching photograph locations with green space locations from the new

Ordnance Survey (2017) map of UK greenspace, the London Greenspace Map (Greenspace Information for Greater London, 2016) and Scotland's Greenspace Map (Greenspace Scotland, 2011), using QGIS (QGIS Development Team, 2018). The photographs with coordinates within or touching a greenspace polygon were included for analysis. Using the photo categories to ascertain what types of greenspace are preferred allows the data to be used to show how scenic different types of greenspace are perceived to be.

4.3.1 Data

Table 7 summarises the datasets which were used in this study. Open-data are those which can be freely downloaded from the internet. Crowdsourced data are datasets which are contributed to by a large group of people.

Table 7: Datasets used in this scenicness study, summary.

Dataset	**Open data?**	**Crowd-sourced**	**Includes**
Scenic-or-Not	**Yes**	**Yes**	Crowdsourced ratings for geotagged images of Britain
Geograph	**Yes**	**Yes**	Crowdsourced geotagged images of Britain, category, description. Source of Scenic-or-Not images.
London Greenspace	No	No	Locations and planning category of London's greenspaces
Scotland Greenspace	No	No	Locations and planning category of Scotland's greenspaces
Ordnance Survey Open Greenspace	**Yes**	No	Locations and category of Britain's greenspaces
Ordnance Survey Boundary Line	**Yes**	No	Boundaries of UK areas including regions and borough/district/county.
Scotland Localities	**Yes**	No	Settlements in Scotland.
England and Wales Major Towns and Cities	**Yes**	No	Large urban areas in England and Wales

4.3.2 Pilot study method

As the national greenspace map was not released until 2017, existing data for London (Greenspace Information for Greater London, 2017) and Scotland (Greenspace Scotland, 2011) were compared to crowdsourced Scenic-or-Not scores. QGIS (QGIS Development Team, 2018) was used to join the attributes by location and determine the scenicness score for each of the categories of park used in the greenspace maps. Images not located in a greenspace were not included in the analysis.

In the London dataset, the greenspace categories are based on the open space typologies laid out in the, now defunct, *Planning Policy Guidance 17: Planning for Open Space, Sport and Recreation* (PPG17) (Department for Communities and Local Government, 2002) (see Figure 47). Similarly, the categories in Scotland are based on planning guidance PAN65, *Planning Advice Note 65: Planning and open space* (Scottish Government, 2008) (see Figure 45). These categories give greater detail on the type of greenspace than the OS Open Greenspace categories.

4.3.3 Pilot results

Figure 45 to 48 show the mean scenicness score in greenspace, in Scotland and London. Figures 45 and 47 show the mean Scenic-or-Not score for each photo and show the median of these mean scores for each of the greenspace categories. Figures 46 and 48 show the median score and also the mean of all of the individual scores for all of the photos in a particular category. This is the grand mean of all of the scores given to photos in the category, as opposed to the mean of the mean scores of the photos within the category. The two methods, median of means and grand mean, resulted in a different order in the rank of the scenicness scores. As the number of scores per image varied, the mean and the grand mean may also differ. The difference between grand mean and median is due to the fact that some of the categories have a skewed distribution in their scores.

The more natural categories tended to be closer to the top of the ranking and the man-made categories tended to be towards the bottom in both London and Scotland, and when using either measure of central tendency (grand mean or median of mean score). In the case of Scotland, the two top places are taken by water features. Water is not specifically mentioned in the London categories.

In the London data the ‘outdoor sports facilities’ category is one notable exception. Based on the mean this appears in the top half of rankings, suggesting that some particularly scenic outdoor sports facilities were skewing the data and resulting in a higher mean than median. An examination of the high scoring photos in this case revealed that they were not necessarily representative of sports facilities in general. For example, the highest scoring photo, at 6.5, was a view of a small tributary, and the second, at 6.43, was a tree-lined view of a sunset. These two, like many of the high scoring photos in this category, were taken on golf courses. The extensive and relatively natural appearance of these photos/areas was different to other outdoor sports facilities, such as football pitches or tennis courts, which have a more man-made appearance. For this reason, golf courses were kept separate from other sporting facilities in the later analysis for the whole of Britain. In this pilot study the category assigned to each greenspace on the greenspace map was used. In the case of the London data, the category used was the planning category (PPG17), which does not separate golf courses from other sports facilities.

The categories with fewer than 5 photos were ignored for the purposes of the discussion as very small sample sizes do not provide for a robust analysis. In London the ‘unclassified’ category can also be ignored as there is no further information about what types of greenspace were included in this category.

In both datasets, scores for natural types of greenspace (e.g. open semi-natural, natural and semi-natural) were similar to those for parks. The data did not demonstrate that people have strong preference for formal parks over more natural types of parks, and therefore change to a more natural style of management may not have a negative impact on people's enjoyment.

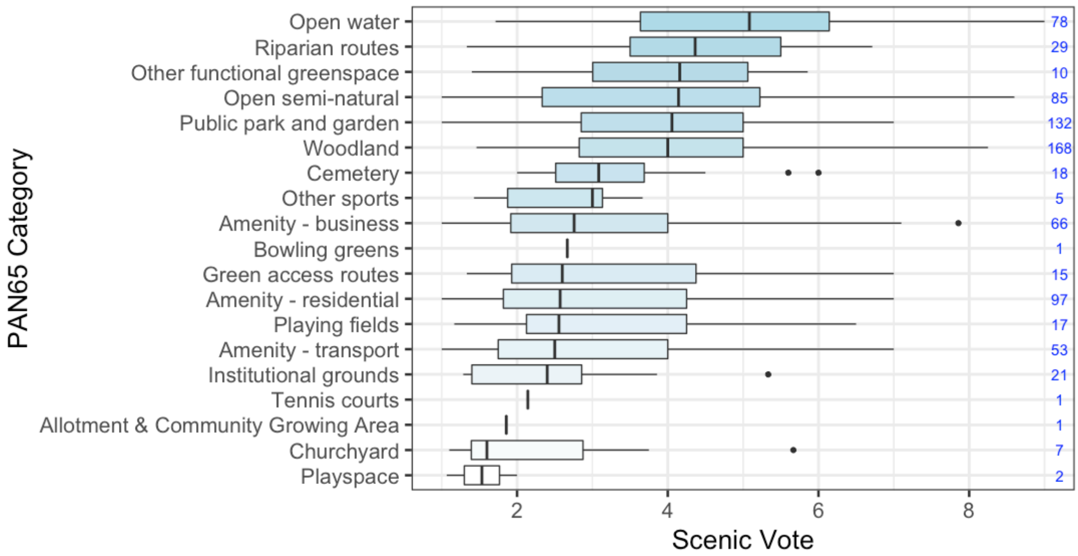


Figure 45: Boxplot of Scenic-or-Not scores in Scotland's greenspaces by planning (PAN65) category. Lower and upper hinges correspond to the first and third quartiles, central line is median of the mean score. Numbers to right are number of observations/photos.

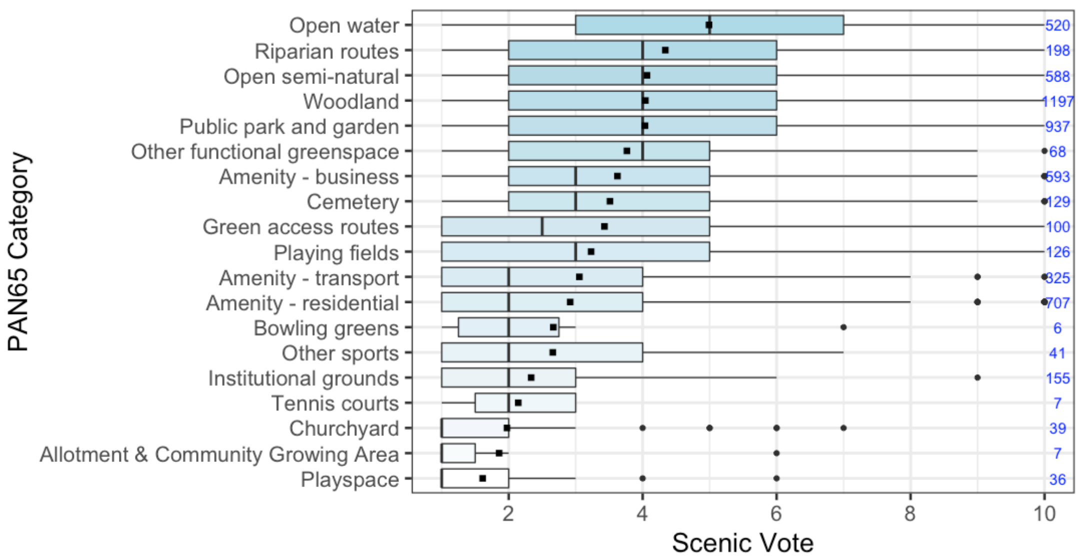


Figure 46: Boxplot of Scenic-or-Not scores in Scotland's greenspaces by planning (PAN65) category. Central line is median and black square is grand mean of all scores for all photos in the category. Numbers to right are number of observations/scores.

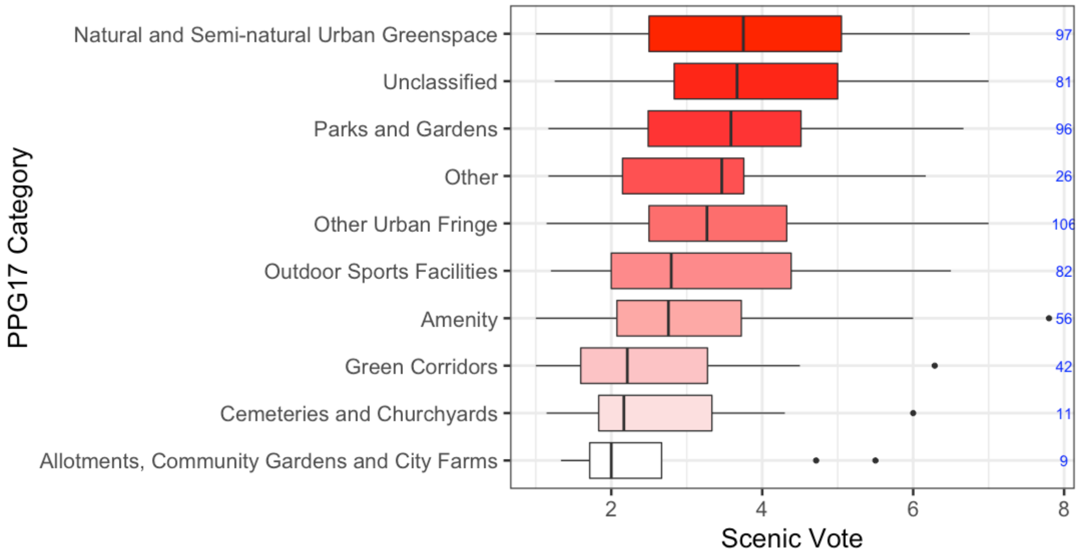


Figure 47: Boxplot of Scenic-or-Not scores in London's greenspaces by planning category (PPG17). Lower and upper hinges correspond to the first and third quartiles. The central line is median of the mean score per photo. Numbers to right are number of observations/photos.

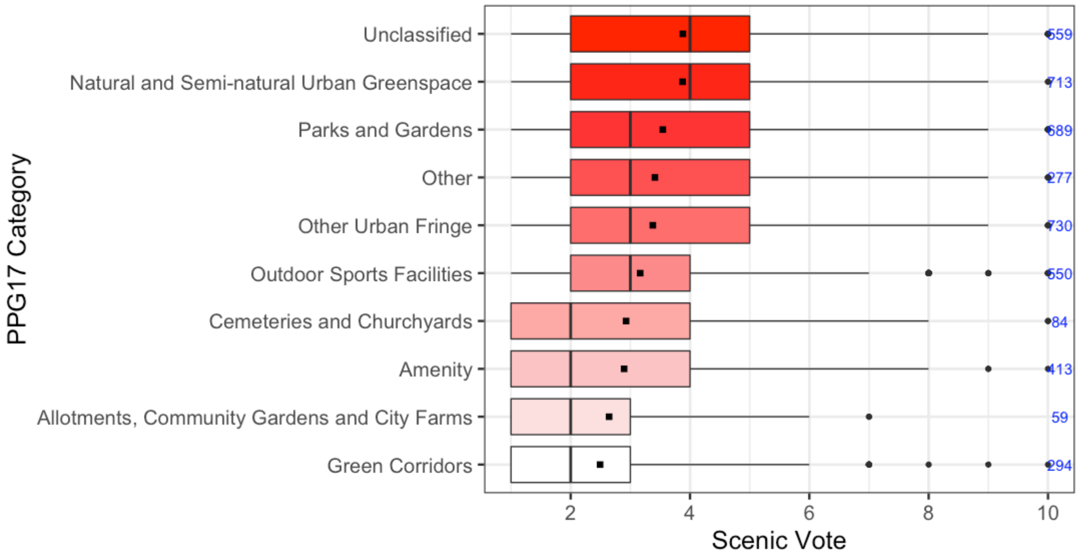


Figure 48: Boxplot of Scenic-or-Not scores in London's greenspaces by planning (PPG17) category. Central line is median and black square is grand mean of all scores for all photos in the category. Numbers to right are number of observations/scores.

4.3.4 Method for Ordnance Survey Greenspace Map

When the national Ordnance Survey Greenspace (Ordnance Survey, 2017) map became available in 2017, it was first analysed using the same method as used in the pilot. The attributes were joined by location, to match the greenspaces on the national map to the Scenic-or-Not scores, using QGIS (QGIS Development Team, 2018). Images not taken within a greenspace were removed from the dataset leaving 2463 images for the analysis.

The Ordnance Survey (OS) has produced two greenspace maps. The first is an open map, viewable online and downloadable free of charge, produced with the aim of allowing the public to find greenspaces to visit. The second is a map available via subscription aimed at local authorities and other professional users. OS has used its own classifications of greenspaces on the maps. The categorisation of greenspaces on both maps is inadequate for the purposes of this research. For example, a formal park and an urban nature reserve would both be categorised as ‘Parks and Gardens’, which makes it difficult to use the data to demonstrate whether the public prefer natural or formal greenspaces. These categories also do not seem very enlightening for a member of the public planning a visit. The version available via subscription has a second level of categorisation, ‘land use’. This categorisation could have been more useful for this research, with categories including woodland. The second category, however, is missing in a large proportion of the records. As a result the professional dataset does not hold any more useful information than the open data for the purposes of this study, so the decision was made to use the open data. The open dataset is smaller and, therefore, more straightforward to process. The whole dataset can be stored on a laptop and processed in QGIS (QGIS Development Team, 2018).

As the Ordnance Survey data did not use a greenspace categorisation that was useful here, the categories assigned by the volunteer photographers who submitted the original photos to Geograph (the original source of the Scenic-or-Not photos) were used. Further data were collected from the Geograph website using ParseHub (2017), a website scraping software, to extract more information on each of the greenspace images, including the category assigned by the volunteer photographer. This process resulted in around 400 categories which were reduced to 35 categories by the procedure described below (see Appendix 2.1 for further details).

All records where buildings were the dominant feature in the description (house, street etc) were removed, with the exception of greenspace buildings such as pavilions. Very specific categories were assigned to a new category using the Geograph description and/or OS Greenspace category. For example, ‘Animal farm park’ and ‘animal husbandry’ were assigned to ‘pasture’, and ‘archaeology’ was assigned to ‘historic’. Similar categories were grouped, for example ‘path’, ‘bridleway’, ‘footpath’ and ‘cycle-path’. All sports were grouped, except golf due to its distinctive and extensive nature. ‘Park buildings’ includes bandstand, pavilion, café. ‘Country house’ and ‘country estate’ were merged, most of the latter also featured the house; ‘country estate’ was used to refer to the merged category. Downland, heathland and moorland were grouped, as they appear similar, and volunteer photographers were unlikely to have sufficient knowledge of ecology to accurately distinguish between them.

After all of the above mergers and exclusions were complete, any category with less than 10 photos had its contents reassigned, with its contents manually reclassified using the category from OS Open Greenspace, the description from Geograph and examination of the image. Once this process was complete, 2453 greenspace images, with a total of 17781 votes, remained for analysis.

Table 8 shows a random sample of 25 images, 1% of the total. The sample was created by assigning a random number to all of the images and then selecting the 25 lowest numbers. In this sample there was just one photo where neither the Ordnance Survey category (category 1 in Table 8 nor the category assigned here (category 3 in Table 8) gave a particularly accurate description of the photo. The photo shows a disused reservoir, now dry, hence the assigned category (category 3) 'waterbody', based on the word reservoir in its Geograph category (category 2 in Table 8), is inaccurate. The OS category (category 1) of the 'waterbody' is 'golf course', but there is no evidence of this use in the image. There were four cases where the categories were different but both categories provided a good description of the image, eight where the category was the same or very similar, and 11 where the new category assigned (category 3) was preferred to the OS category (category 1). There were no instances where the OS Function better described the photo. This demonstrates that the process assigned photos to a suitable category in the majority of cases and improved on the categories assigned by OS.

Note that all of the scored images in this subset were taken in a greenspace as shown on the OS Open Greenspace map. Some of the categories assigned here correlated well with the park typologies used in the London and Scotland datasets, e.g. 'country park' and 'burial ground'. Some of the categories were landscape or park features, as opposed to categorising the whole site, for example 'hill' or 'park building'. Due to the lack of standardisation in this crowdsourced data, some photos were categorised at the landscape level and some at a finer scale.

The location of the greenspaces was also investigated to find whether this is an important driver for their scenicness which may have had an effect on the relationship between scenicness and greenspace type. Scenicness scores for each regions were compared. And scenicness scores were correlated with the latitude and longitude of greenspaces.

The effect of whether greenspaces were located in major towns and cities or in smaller urban areas upon their scenicness was investigated. Greenspaces outside of major towns and cities are likely to have more natural views so this could impact upon their scenicness. If the location of greenspace had a large effect on scenicness this may have had an effect on the results in relation to the category of park. There is not a single dataset of major towns and cities for the whole of Britain. For England and Wales, one of the available datasets is *Built-up Areas* (Office for National Statistics 2011). This dataset includes small settlements, using this dataset would have resulted in most greenspaces being classed as within or adjoining an urban area, even if they are located in or adjoining a small village. This would have encompassed the vast majority of Britain's greenspaces on the OS map (Ordnance Survey, 2017). The *Major Towns and Cities* (Office for National Statistics 2015) dataset was used, as this contains only larger urban areas. "Major Towns and Cities (TCITY) statistical geography provides a precise definition of the major towns and cities in England and Wales" (Office for National Statistics 2015). This dataset contains 112 major towns and cities.

For Scotland, the *Localities* (National Records Scotland 2016) dataset was used. This also includes small settlements; there was no major town and city dataset available for Scotland, so all urban areas smaller than $10km^2$ in the *Localities* dataset were removed to create a dataset only including larger conurbations. The areas of the remaining Scottish towns and cities were then comparable to the England/Wales dataset, where the smallest major town or city was $14km^2$. This resulted in 27 large towns and cities for Scotland.

The size of a greenspace could be an important predictor of scenicness if people enjoy wide, open views. Thus, the relationship between greenspace area and scenicness score is also investigated.

Table 8: Random sample of images to check accuracy of assigned category

Photo	SoN Score	1. Function (OS Greenspace)	2. Geograph Category	3. New Category	Preferred category (OS/New)
	2.2857	Public Park or Garden	Entrance	Entrance	Either
	3	Public Park or Garden	Sculpture	Country park	Either
	5.3333	Public Park or Garden	Parkland	Parkland	Either
	2.125	Public Park or Garden	Common	Common	Either
	4.4286	Golf Course	Reservoir (disused)	Waterbody	Neither
	4.8571	Golf Course	Farming activity	Arable	New (3)
	5.1429	Golf Course	Canal bridge	Canal	New (3)

Photo	SoN Score	1. Function (OS Greenspace)	2. Geograph Category	3. New Category	Preferred category (OS/New)
	4	Golf Course	Bridge	Bridge	New (3)
	4.2857	Public Park or Garden	Parkland	Parkland	New (3)
	4.25	Public Park or Garden	Railway (dismantled)	Path	New (3)
	2	Playing Field	Tidal creek	Watercourse	New (3)
	3.4	Public Park or Garden	Cricket pavilion	Park building	New (3)
	6.3333	Religious Grounds	Path	Path	New (3)
	3.1667	Public Park or Garden	Woodland, Forest	Woodland	New (3)

Photo	SoN Score	1. Function (OS Greenspace)	2. Geograph Category	3. New Category	Preferred category (OS/New)
	3.6667	Golf Course	Track	Track	New (3)
	1.4286	Playing Field	Circus (travelling entertainers)	Event	New (3)
	4.125	Golf Course	Golf course	Golf course	Same
	3.8	Golf Course	Golf course	Golf course	Same
	5.1429	Golf Course	Golf course	Golf course	Same
	3.3333	Golf Course	Golf course	Golf course	Same
	2.8333	Cemetery	Cemetery	Burial ground	Similar

Photo	SoN Score	1. Function (OS Greenspace)	2. Geograph Category	3. New Category	Preferred category (OS/New)
	3.1	Public Park or Garden	Picnic area	Park	Similar
	3.5	Religious Grounds	Graveyard	Burial ground	Similar
	4.875	Public Park or Garden	Snowscene	Park	Similar

4.3.5 Software

Spatial matching was carried out in QGIS (QGIS Development Team, 2018). Data analysis, regressions and Tukeys HSD test were carried out in R (R core team, 2017) using the MASS package (Ripley, 2011). Data were visualised using R, and the ggplot2 package (Wickham, 2009). ParseHub (2017) was used to scrape the Geograph website.

4.3.6 Spatial differences

The relationship between scenicness the type of greenspace may be complicated by the location where an image was taken. For example, differences in the surrounding scenery in different areas of the country. Linear models were created to examine the relationship between scenicness of images taken in greenspace and their location. As the analysis was designed to capture correlation by location, allowance was not made for spatial autocorrelation. As stated by Hawkins, “[i]f spatial autocorrelation is part of nature, and we are trying to understand nature, it makes little sense to claim that spatial autocorrelation in data represents some sort of bias, artefact or distortion” (Hawkins, 2012).

Images from the north were more scenic than those in the south. The effect is small; correlation coefficient of 0.055, p = < 0.0001 (see Appendix 2.5). Images from the west were more scenic than those from the east. The effect is small, though slightly larger than that for latitude (correlation coefficient of 0.114, p = < 0.0001) (see Appendix 2.5). In both cases the R^2 is very low (0.004 and 0.016 respectively) and location only explains a small proportion of the variation in the scenicness scores.

Using Ordnance Survey Boundary-line (2018) open dataset, the Scenic-or-Not scores for greenspace images were analysed by Euro Region, which divides England into 9 regions and treats Wales and Scotland as regions. Of the Euro Regions, Scotland has the most scenic greenspaces and London the least (coefficient -0.951), p = <0.0001. Wales and the South West were closer to Scotland in scenicness than any of the other regions, but for Wales and the South West the results were not statistically significant. The remainder were as follows, in order of decreasing scenicness: South East -0.42874, West Midlands -0.44134, North West -0.45686, Eastern -0.46791, East Midlands -0.51262, Yorkshire and the Humber -0.62617, North East -0.68084, London -0.95173 p = <0.0001. This analysis does not show that there is a simple north/south or east/west pattern (see Appendix 2.5). Figure 49 is a map of the mean scenicness score by Euro Region, the differences by region were small.

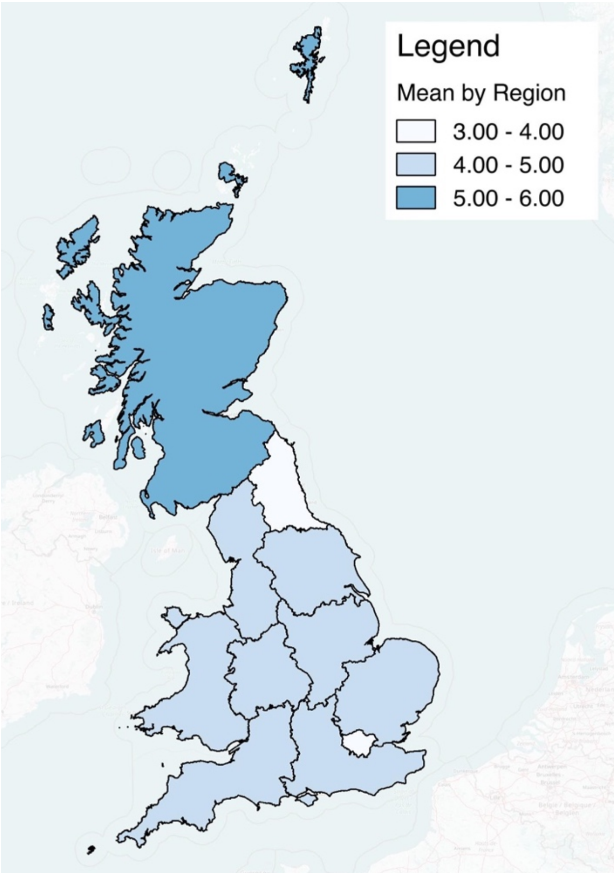


Figure 49: Map of mean scenicness score of greenspaces by Euro Region. Map created in QGIS (QGIS Development Team, 2018)*. Base map from* OpenStreetMap (2017)*.*

The English regions were then further grouped into: North (North East, North West, Yorkshire and Humber), South: (South East, South West, Eastern and London) and Midlands (West Midlands and East Midlands). The linear model for the resulting larger English regions, and scenicness score, shows that all of the regions have lower scenic scores for their greenspaces than Scotland; correlation coefficient is close to -0.5 in all cases, again the effect is small. The coefficients were similar for all of these English regions. In the case of Wales, the coefficient is smaller (-0.211) and not statistically significant (see Appendix 2.5). As the location of the image had only a small effect it is unlikely to affect the relationship between scenicness and greenspace type.

4.4 Results

Figure 50 shows the distribution of all Scenic-or-Not scored images, with three or more user scores, throughout Great Britain, including those which do not coincide with a greenspace. Note that the white areas, mostly in the far north, are locations for which there were no images with three or more scores. This is due to the remote nature of these locations, which resulted in a lack of visits by volunteer photographers. The normal feature blending mode in QGIS was used as there were many overlapping points representing the images on this map. This mode uses the alpha channel (transparency) of the top pixel to blend the overlapping points.

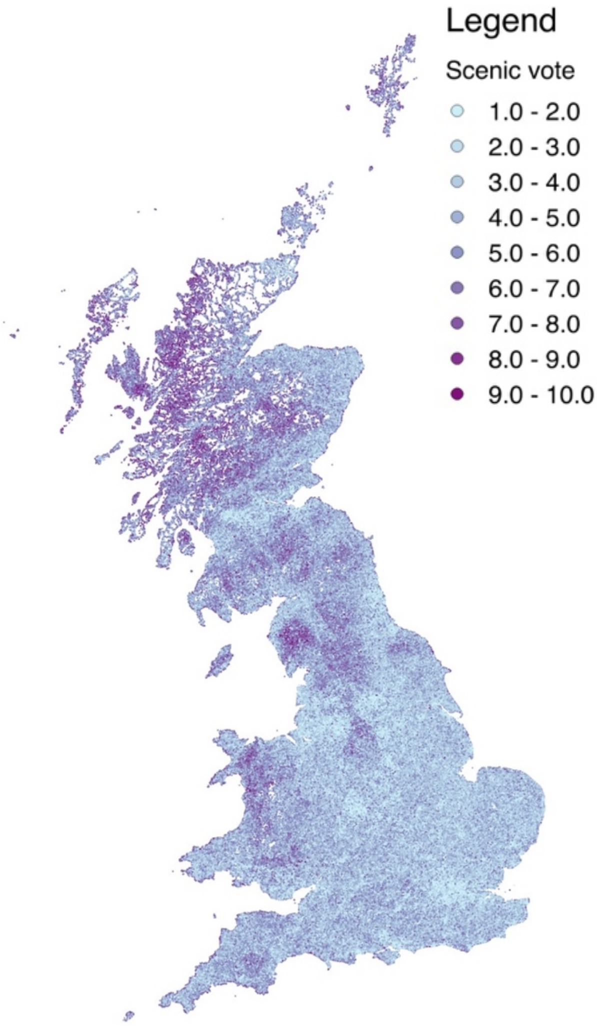


Figure 50: Map of Scenic-or-Not scores for Great Britain. Trend is: greater scenicness towards North West and around coast. White areas are locations where, due to their remote nature, there is not a scored image. Map created in QGIS (QGIS Development Team, 2018). *Base map from* OpenStreetMap (2017).

Images which coincide with a greenspace but depict an irrelevant category, such as a street scene, were removed. This could occur, for example, where the photographer was standing at the edge of a greenspace looking outwards or where the location was incorrect on Geograph. See Figure 51 for the locations of the images removed due to irrelevant categories.

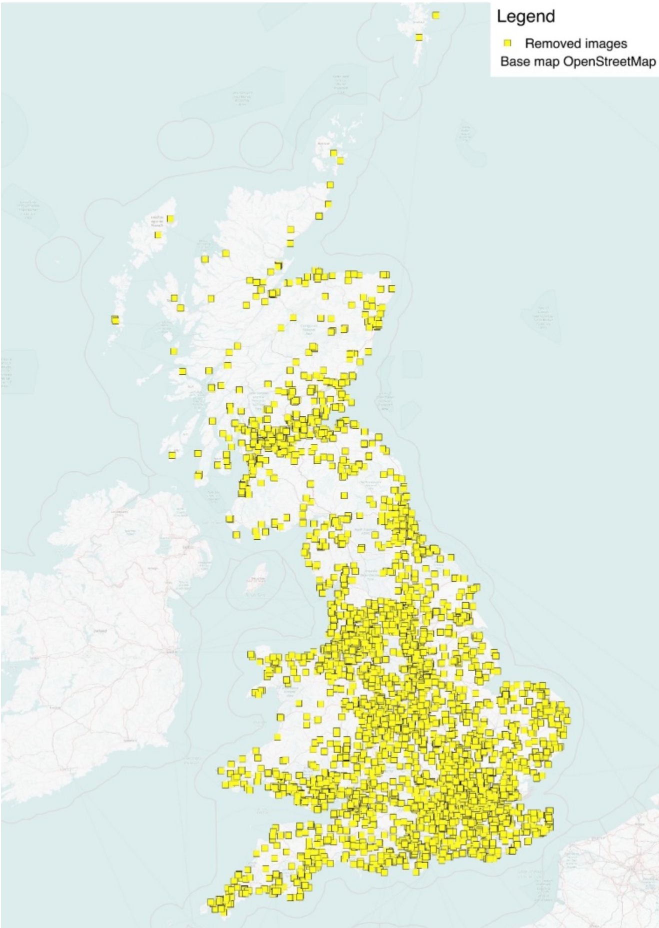


Figure 51: Images from Scenic-or-Not which were found to coincide with a greenspace on Ordnance Survey's Open Greenspace Map but were removed as they belonged to an irrelevant category according to their listing on Geograph. Map created in QGIS (QGIS Development Team, 2018). Base map from OpenStreetMap (2017).

Figure 52: Maps of locations of Scenic-or-Not scores which coincide with a greenspace on the Ordnance Survey's map. Map created in QGIS (QGIS Development Team, 2018). *Base map from* OpenStreetMap (2017).

In Figure 52 the remaining scored greenspace images show a good distribution of images around England, Scotland and Wales. The gaps largely coincide with more rural areas where there is little or no urban greenspace.

These maps show that there were scenic and less scenic greenspace images located throughout the country. This is in contrast to the complete Scenic-or-Not dataset where, the north and west, and the coasts, tended to have more scenic images (Figure 50). This pattern is also reflected in the Scenic-or-Not leader-board of the most and least scenic images on the website. On 12 March 2019, the top five were all in Scotland, and the bottom three were all in England. Figure 53 shows a sample of the greenspace map at a finer scale, also showing the greenspaces on the Ordnance Survey's Open Greenspace map.

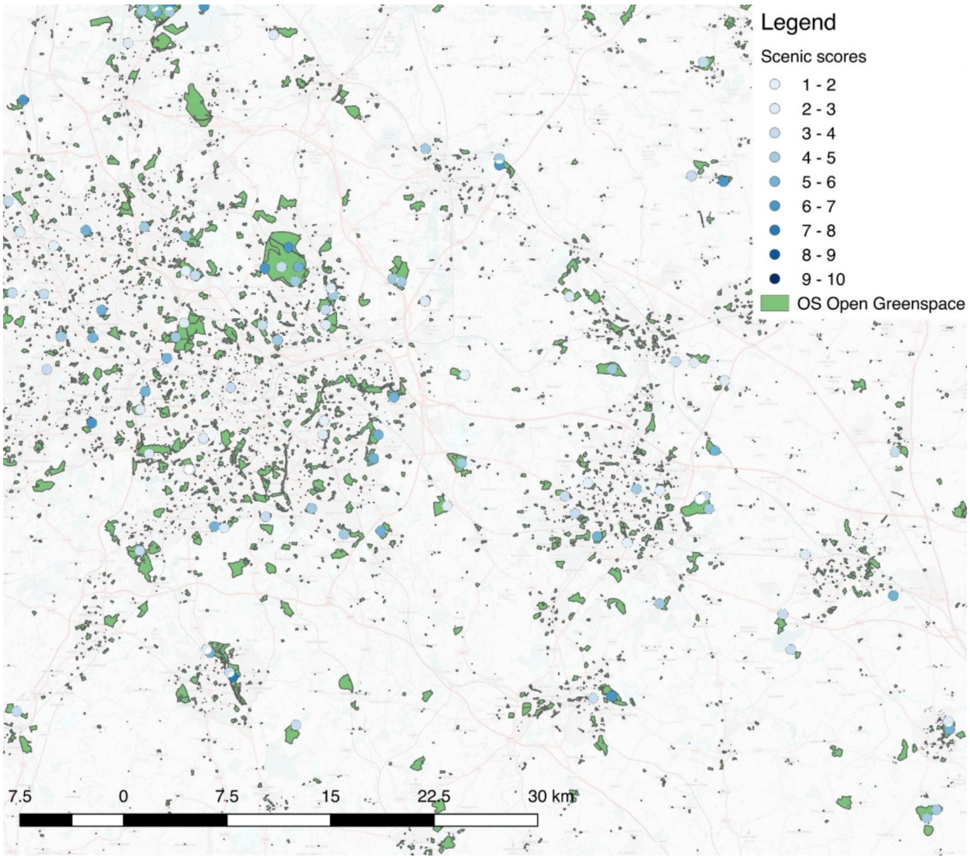


Figure 53: Map of Scenic-or-Not scores coinciding with an Ordnance Survey mapped greenspace in part of the West Midlands. Map created in QGIS (QGIS Development Team, 2018)*. Base map from* OpenStreetMap (2017)*.*

Data were initially examined using the categories assigned by the Ordnance Survey. A boxplot (Figure 54) of the scenicness vote by category shows that 'public park or garden' is the most scenic category and 'tennis court' the least. This pattern is similar to the results using the Scotland and London data where the most natural categories score highest and the more man-made features score lowest. There is overlap between the distributions but the categories are very broad and further subdivision of the categories below draws out greater difference between different types of image.

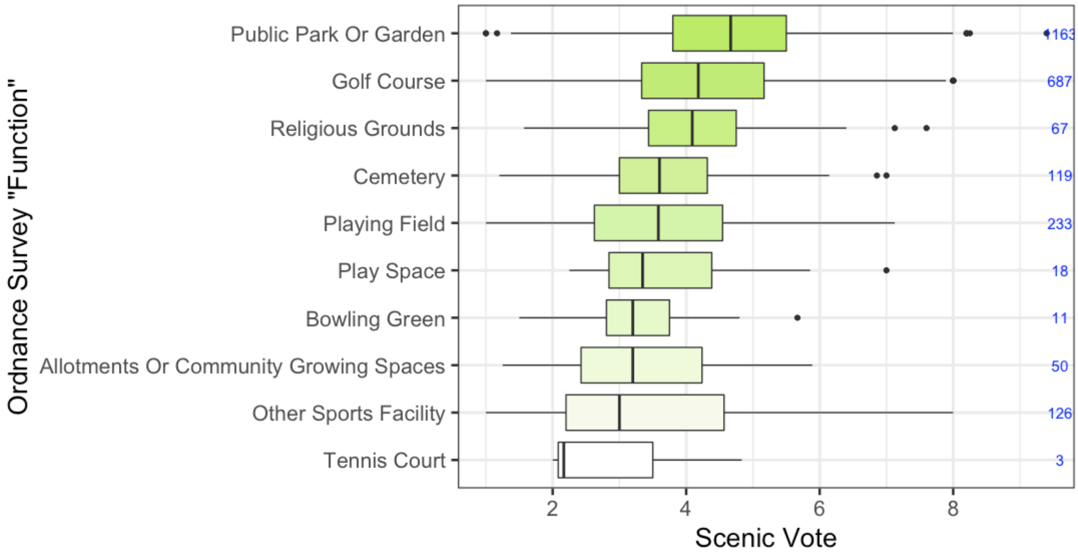


Figure 54: Boxplot of Scenic-or-Not scores of British greenspaces by category assigned by Ordnance Survey. Lower and upper hinges correspond to the first and third quartiles, central line is median of the mean score per photo. Numbers on right are number of observations/photos.

As the 'public park and garden' category covers a wide range of greenspaces it is not possible to compare naturalistic to more formal management. For example, this category could include urban nature reserves as well as traditional manicured parks. The categories assigned by the volunteer photographer on Geograph, then refined here, give more information about the features of the images.

Analysis of the national OS Greenspace map using the categories based on those assigned on Geograph showed that infrastructure (playgrounds, sports facilities) received the lowest scores and natural features (hill, moorland) received the highest scores (Figure 55). Park, nature reserve, garden and country park received very similar scores, suggesting that there is not a strong preference for formal over natural types of greenspace.

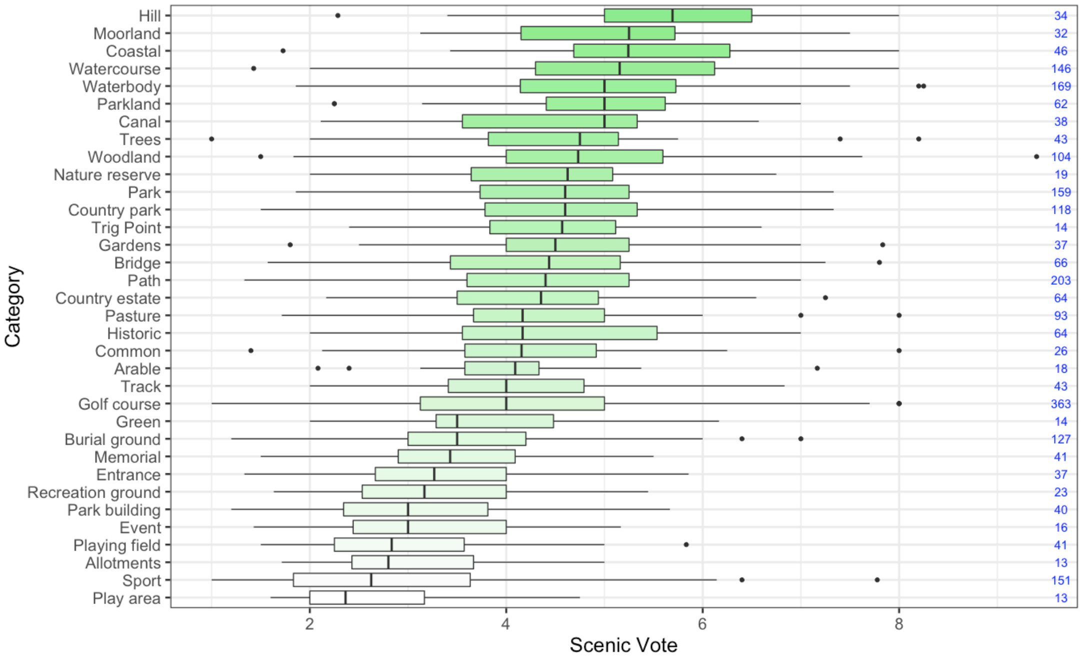


Figure 55: Boxplot of Scenic-or-Not scores in greenspaces, and photo category assigned based on categories from Geograph. Lower and upper hinges correspond to the first and third quartiles, central line is median of the mean score per photo. Numbers to the right are the number of observations/photos.

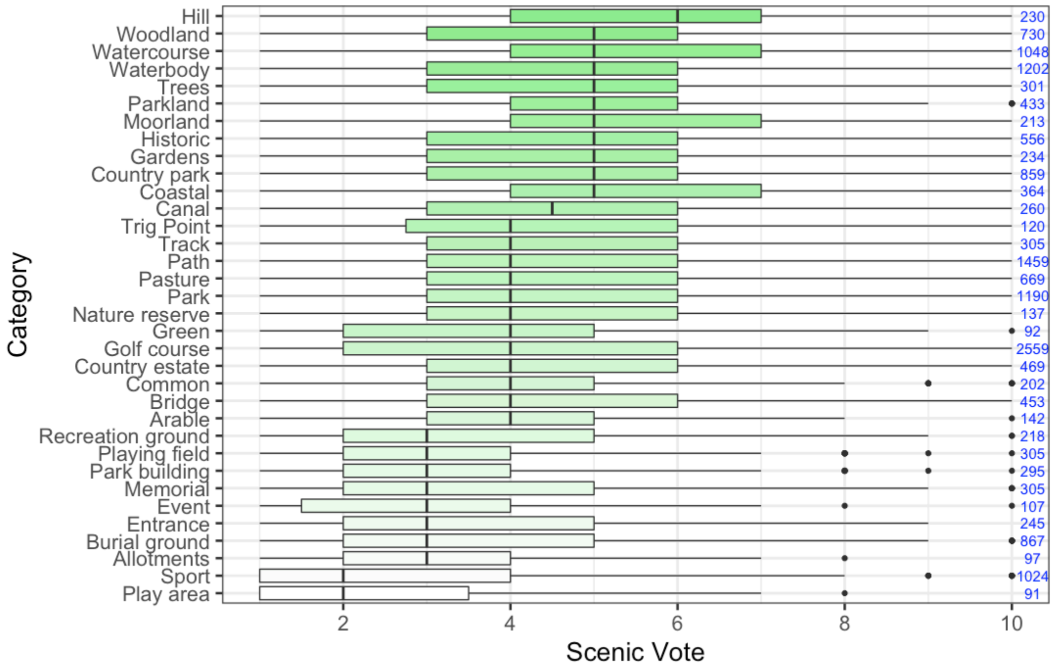


Figure 56: Boxplot of median Scenic-or-Not score in greenspaces, by photo category assigned based on Geograph. Lower and upper hinges correspond to the first and third quartiles, central line is median score of all photos in the category. Numbers to the right are the number of observations/votes.

Figure 55 shows the mean Scenic-or-Not scores by photo. The central line in each bar is the median of this mean score. Figure 56 shows the median Scenic-or-Not scores by photo category and the central line is the median vote for all greenspace images in the category. The median of means boxplot (Figure 55) treats the photo as the unit of measurement, within the category, whereas the median boxplot (Figure 56) uses the median of all of the votes in the category. Using the median for all photos in a category appears to reduce the variability between the categories. This is because the median will be an integer between one and ten, whereas the mean of the scores for an image need not be a whole number.

As in the pilot, the first boxplot (Figure 55) uses the median of the mean scores per image and the second boxplot (Figure 56) median and mean of all of the images in each category. This results in slightly different ranks of the photo categories by scenicness score due to some categories having slightly skewed distributions in their scores. This effect is less noticeable than in the pilot study, probably due to the larger sample size leading to a reduction in the effect of outliers and a reduced standard deviation.

Figure 57 shows a subset of the national data where the categories represent a greenspace type (using the categories assigned here based on those assigned by the volunteer photographers). The categories removed in this graph are better described as greenspace features, for example the category ‘watercourse’, which then makes the pattern of higher scores in more natural greenspace types clearer. The key categories, park and gardens (formal) nature reserve and country park (more natural) were very similar in scenicness score.

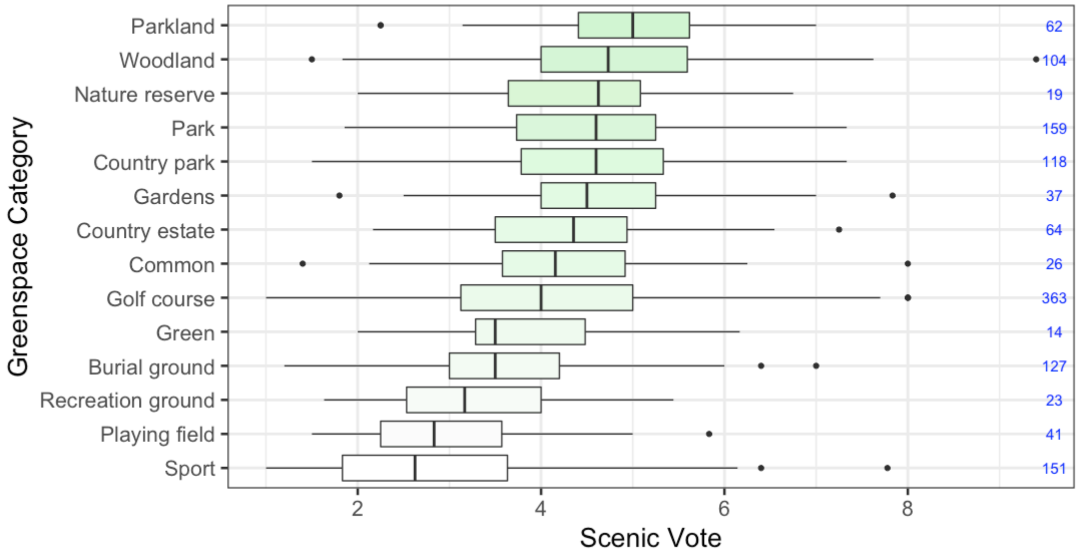


Figure 57: Boxplot of scenicness by photo category which denotes a greenspace type only. Central line is the median of the mean score per image. Numbers to right are number of photos.

Table 9 shows a representative selection of greenspace images with high scores (over 8), low scores (less than 2) and photos with scores in the middle of the range (5). Low scoring images were dominated by man-made structures and surfaces, or vast, flat expanses of closely mown grass. Photos with scores in the middle of the range tended to include a mixture of natural and man-made features, and some flat expanses of grass. The highest scoring images were largely natural, including hills, woodland and water. Some of the high scoring images included attractive man-made features such as historic buildings.

Table 9: Showing representative images taken in greenspaces shown on the Ordnance Survey's Open Greenspace Map, their category assigned here and their scores from Scenic or Not.

	Golf	Sport	Entrance
Score under 2			
	Golf	Watercourse	Country park
Score 5			
	Woodland	Waterbody	Trees
Score over 8			

The categories were further grouped, manually, by naturalness from largely natural to very managed, to investigate which broader categories were the most scenic. This grouping resulted in four broad categories, see *Table 10*.

Table 10: Photo categories further grouped natural to man-made.

Natural	**Managed natural**	**Man-made green**	**Man-made**
Hill	Country park	Allotments	Bridge
Coastal	Country estate	Arable	Burial ground
Moorland	Gardens	Canal	Entrance
Trees	Green	Common	Event
Water body	Nature reserve	Golf course	Historic
Watercourse	Park	Pasture	Memorial
Woodland	Parkland	Play area	Park building
		Playing field	Path
		Recreation ground	Track
		Sport	Trig Point

Figure 58 is a boxplot of the mean vote per photo in these new grouped categories. The plot shows the median for each category of these mean votes. The more natural the category the higher the mean score that the photos received and the more man-made the category the lower the score.

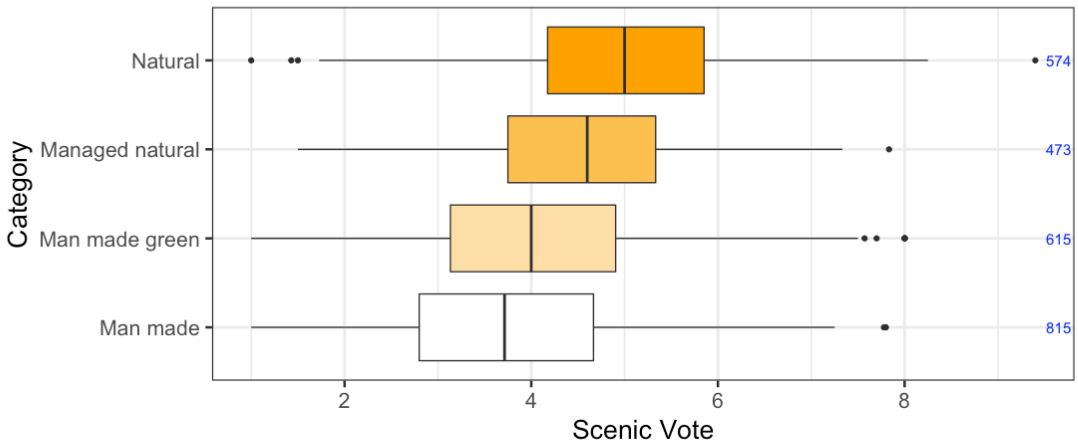


Figure 58: Boxplot of Scenic-or-Not scores in British greenspaces in further grouped categories based on categories assigned on Geograph. Numbers to right are number of scored photos in each category.

4.5 Analysis

4.5.1 ANOVA

The ANOVA result (Appendix 2.3: Analysis of Variance and Tukey HSD) showed that the variation in scenic scores between photo categories is greater than the variation within categories (*P* <0.00001 and the F value is 21.22). This means that there is a significant difference in the variation of scenicness in the photos between categories.

4.5.2 Tukey

A pairwise comparison of the photo categories (Appendix 2.3: Analysis of Variance and Tukey HSD) found that the mean scenic score for park was 0.09 higher than nature reserve, park was 0.13 lower than gardens and 0.03 lower than country park. These differences were not significant at a 99% confidence level in all three cases, *p* = 1.00000. This suggests little difference between the scenicness of formal and less formal types of park.

The largest difference, between ‘hill’ and ‘play area’, was -2.96, *p* = <0.00001. In general, more natural park features scored higher than man-made features.

4.5.3 Linear Regression

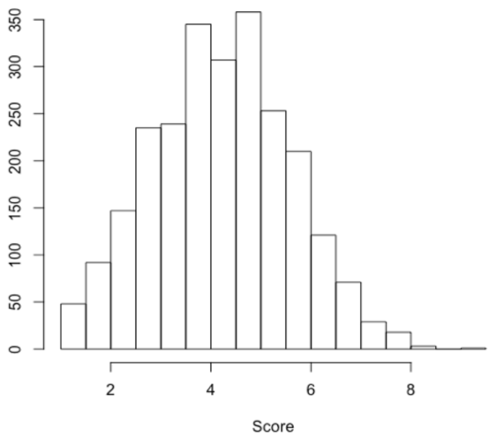


Figure 59: Distribution of mean scenicness scores.

The distribution of the mean scenicness votes is approximately normal, see Figure 59. This allows the use of simple linear models in the analysis of the data.

A linear regression was built with mean scenicness score as the dependent variable and the photo categories as a categorical (dummy) independent variables. 'Park' was the reference variable (see Appendix 2.2: Linear regression). This did not find a significant difference between the mean scenic score for park (the reference variable) and nature reserve, gardens or country park. Again, there was little difference demonstrated between the scenicness of these formal and less formal types of park.

For the other categories, coefficient estimates show that scenicness scores were statistically significantly lower than park (at $p<0.001$) for the following categories in order decreasing size of the effect: play area (-1.74770), sport (-1.63731), allotments (-1.41029), playing field (-1.40668), park building (-1.39277), event (-1.33687), recreation ground (-1.13103), memorial (-1.04105), entrance (-1.02305), burial ground (-0.83606) and golf course (-0.42317). These features all had photos that were rated lower than those of parks. Play area had the largest negative effect at 1.75 time less scenic than parks. Man-made features were the least scenic.

Coefficient estimates indicate that scenic scores were statistically significantly higher than park (at $p<0.001$) for hill (1.21677), coastal (0.88975), watercourse (0.61844) and waterbody (0.48982), in order of decreasing size of the effect. Photos of all of these features were rated as more scenic than photos of parks. The largest difference was for hill, which was 1.22 times more scenic than park. Natural features were considered the most scenic.

An R-squared value of 1 would indicate a perfect, positive correlation between the two variables, where photo category explains all of the variation in scenicness scores. An R-squared of 0 would indicate no relationship. The R-squared of this regression was 0.22, which is quite low. This suggests that other variables may be affecting the scenicness scores in addition to the photo category. This could include factors such as the quality of the photo, features within the photos unrelated to the category (for example an electricity pylon in an otherwise natural picture) or the weather when it was taken.

4.5.4 Relationship between greenspace area and scenicness

The relationship between the scenicness score and the size of the greenspace in which the photo was taken was investigated. Larger greenspaces tend to have more scenic images (see Figure 60). This is of interest to park managers and designers as there is pressure to create smaller greenspaces or sell off areas of existing sites, especially under austerity.

A linear regression of greenspace area and scenicness score gave a correlation coefficient of 0.19. This means that for every 1km^2 of greenspace area, the scenicness score increases by 0.19. This is significant at p=<0.0001. See Appendix 2.4.

The R^2 is very low at 0.026. This means that the size of the greenspace explains only a very small proportion of the variation in the scenicness score of the greenspace image.

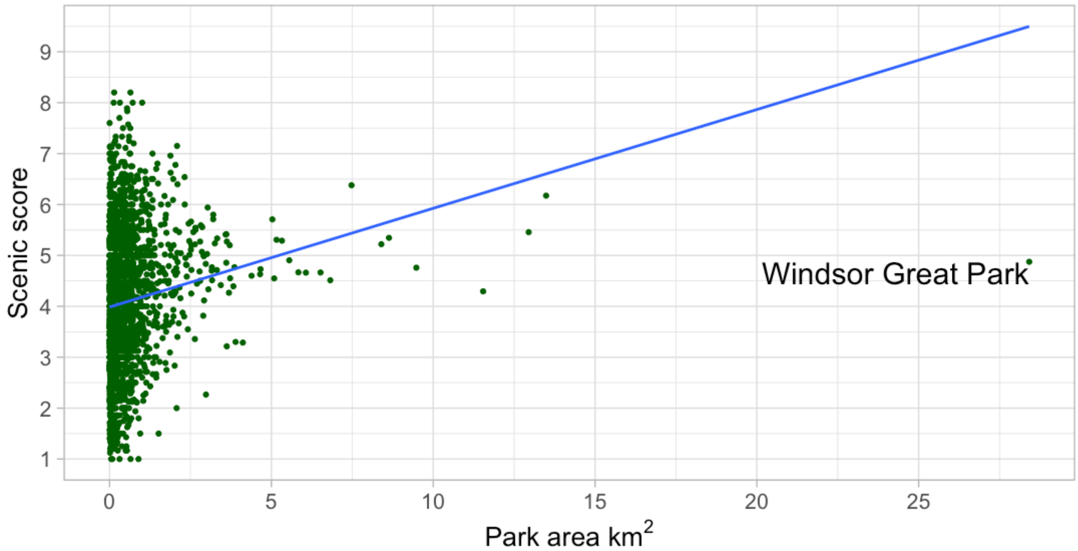


Figure 60: Scatterplot showing Scenic-or-Not score in relation to the area of the greenspace. The points represent individual greenspaces and the blue line represents the linear regression.

There is a significant outlier, Windsor Great Park; by far the largest greenspace in the dataset at over 28km^2. This outlier is exerting a large effect on this result (see point 1485 in the residual plots within Appendix 2.4), this is the point to the far right of Figure 60. This outlier was omitted before re-running the same analyses.

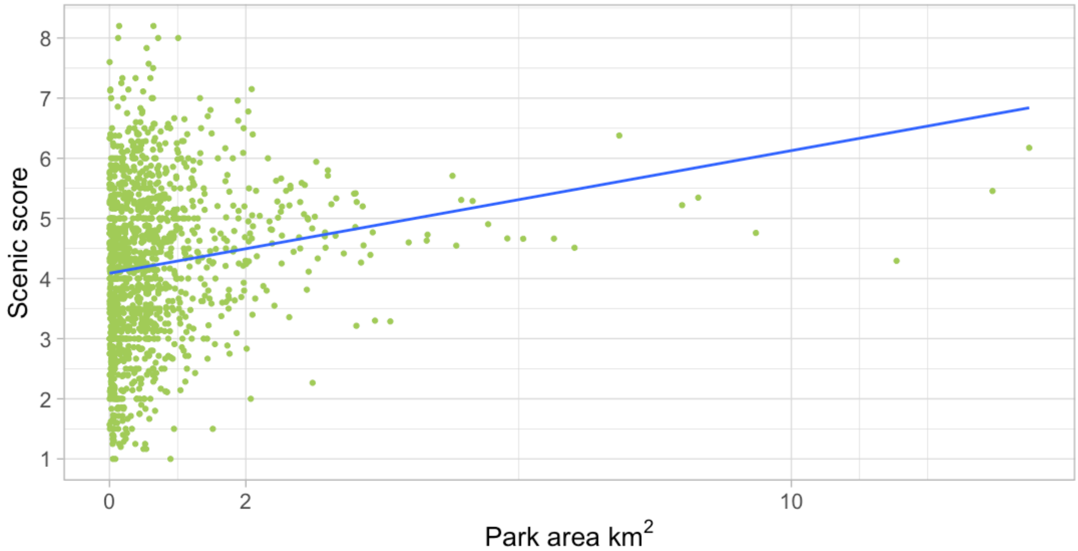


Figure 61: Scatterplot showing Scenic-or-Not score in relation to the area of the greenspace, with the outlier removed. The points represent individual greenspaces and the blue line represents the linear regression.

A linear regression, without the outlier, gave a correlation coefficient of 0.20. This means that for every 1km^2 of greenspace area, scenicness score increases by 0.20. This is significant at *p*=<0.0001 (see Appendix 2.5). This effect is slightly higher than when the outlier was included.

The R^2 is still very low at 0.030, which means that, with the outlier removed, the size of the greenspace still only explains a small proportion of the variation in the scenicness score of the greenspace images. This is slightly higher than in the model including the outlier, so a slightly higher proportion of the variation in the scenicness score is explained. The residual plots are also improved with outlier removed (Appendix 2.5), with no discernible pattern in the residuals and no points creating leverage beyond Cook's distance, which is a measure of the influence of data points (e.g. significant outliers).

4.5.5 Inside or outside of major town or city.

Scenic-or-Not scores were compared for greenspaces within or touching the edge of cities and large towns, and those outside of these areas. The location of a greenspace may affect its scenicness, for example due to the surrounding views.

A linear regression of Scenic-or-Not scores of greenspace images in major towns and cities gave a correlation coefficient of -0.35, meaning that greenspace outside of major towns and cities was slightly more scenic. The R^2 was very low at 0.0126, meaning that being the urban setting of the greenspace images only explains a very small proportion of the variation in scenicness (see Figure 62).

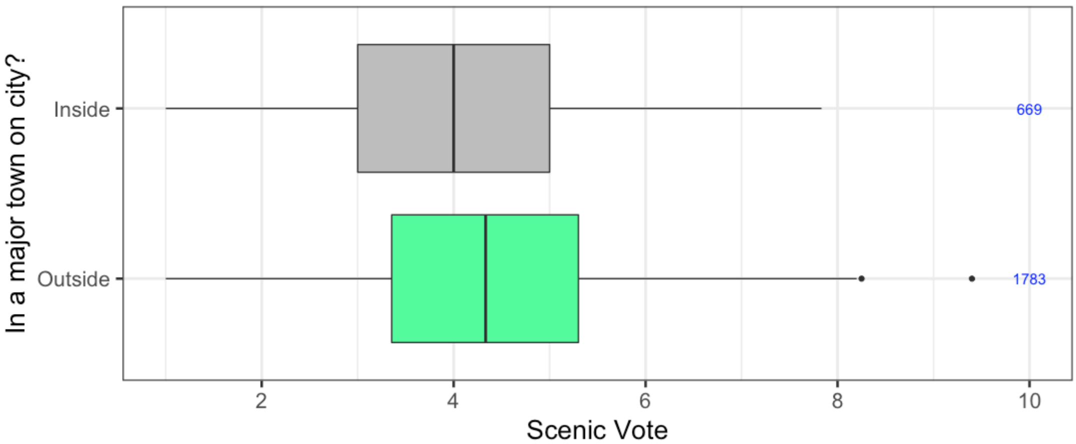


Figure 62: Boxplot of Scenic-or-Not scores of British greenspace photos, inside and outside of major towns and cities. Numbers to the right are number of scored photos.

The scenicness of greenspace images by category is shown below in two boxplots, separated by whether they were located in a major town or city or not (Figure 63 and 64). The patterns were similar as most categories maintained a similar position in the ranking, regardless of whether they were located in a large urban area or not. There are some notable differences however, for example photos taken in an urban greenspace described as ‘coastal’ were less scenic than rural coastal greenspace images, however there were only 4 photos in the ‘coastal’ category. A larger number of scores would provide a more robust result. Urban nature reserves appear to be more scenic than those in rural areas, but this is also based on a small number of images (10 extra-urban and 9 urban nature reserve images).

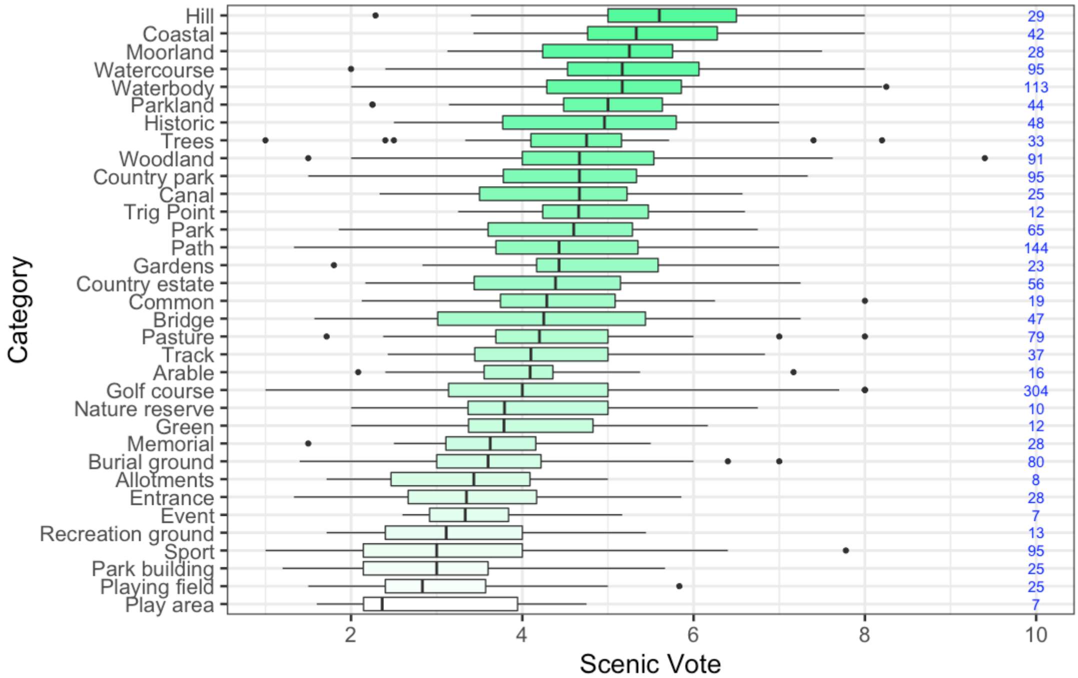


Figure 63: Boxplot of Scenic-or-Not scores in Britain's greenspaces located outside of major towns and cities, by category. Central line is median. Numbers to the right are number of observations/photos.

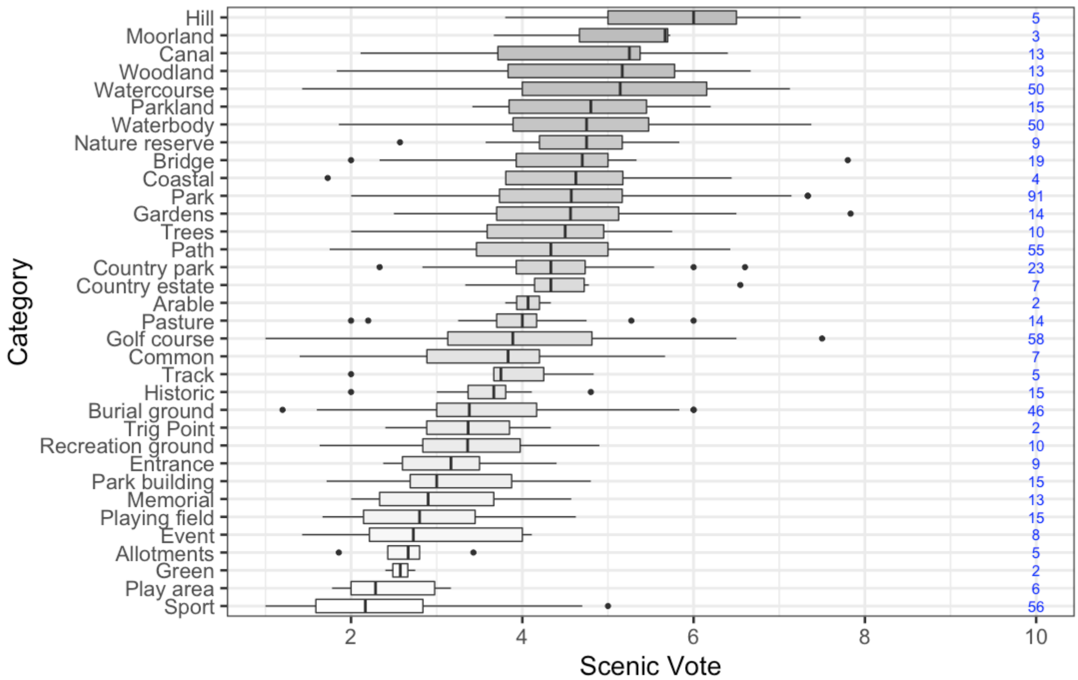


Figure *64*: Boxplot of Scenic-or-Not scores in Britain's greenspaces located in major towns and cities, by category. Central line is median. Numbers to the right are number of observations/photos

4.6 Discussion

This chapter uses crowdsourced ratings of scenicness and a national map of greenspaces to answer the question: do people find naturalistic or formal greenspaces more scenic? This relates to Chapter 3, where the preferences of pollinating insects are investigated and feeds into Chapter 5, which investigates these human preferences at a finer scale.

The data demonstrate that natural features and landscapes are considered more scenic. As natural features are considered more scenic, naturalistic management styles are likely to have a positive effect on scenicness. Naturalistic management can be cheaper than more intensive formal management, for example through reduced mowing operations, so this could reduce costs as well as having a positive effect on scenicness and benefitting wildlife. However, scenic landscape features such as ‘hill’ or ‘watercourse’ are likely to be costly, or impossible, to replicate.

These findings agree with other studies which used the Scenic-or-Not data that more natural views are considered more scenic (Seresinhe, Preis and Moat, 2017; Seresinhe, Moat and Preis, 2018; Seresinhe et al., 2019; Workman, Souvenir and Jacobs, 2017). Van der Jagt *et al.'s* (2014) study, using photographs, also found a correlation between naturalness and scenic quality. Conversely, other studies (Özgüner and Kendle, 2006; Bertram and Rehdanz, 2015) have suggested that neatness and cleanliness were more important than naturalness. In the case of Özgüner and Kendle (2006) the authors even suggest that *some* people find more natural landscapes less aesthetically appealing.

Seresinhe, Preis and Moat (2015) analysed the colour composition of the Scenic-or-Not images and state that green featured in scenic images, but blues and greys dominate the most scenic images, perhaps due to scenic features such as mountains and water which include these colours. Colour analysis of the greenspace subset of images from Scenic-or-Not was not attempted here due to issues with the assignment of colours, which are described in the following chapter.

In the pilots using data from London and Scotland the category of greenspace was assigned by professionals, and in the main study the category of greenspace was assigned by volunteer photographers and refined. The results of the pilots and the main study were similar, this suggests that the results based upon crowdsourced classification of greenspace are also reliable.

There were few images in some categories, especially in the pilot data. The key categories, such as ‘parks’, have a good number of images. In the main study all of the categories have more than 10 photos, as any with less than this were removed and their photos reassigned to another appropriate category.

Some of the greenspace photos could belong to more than one category. For example, ‘woodland’ can be within a country park and could be considered a scenic feature of it. This study relies on the volunteer photographer having assigned the photo to the dominant category, and to the correct category. In the case of the pilot study, the category was assigned by professionals and the patterns were similar, so this demonstrates that scores were likely to be representative of the category. Examination of a selection of photos in the main study suggests that the category was generally a good description of the photo.

Due to their crowdsourced nature, the quality of the photographs is a potential issue with this dataset. For example, a poor photo, or one taken in dull weather, might receive a lower score. Examination of a random sample of the images did not suggest that this was an issue as the sample images were all of good quality.

Scenicness can depend upon features which are not affected by the management of the site, and which those caring for the site have little or no control over, for example hills, rivers and surrounding land-use. This means that often managers cannot improve these elements of scenicness through their day to day operations. Though they could, for example, ensure that views of attractive natural features are maintained, or screen unattractive man-made structures with vegetation. Scenic features could also be considered when developing or redeveloping greenspace, for example inclusion of sloping landforms, water features or woodland.

Scores for categories featuring water, such as ‘watercourse’, were high. When discussing greenspace, it is also important to consider the importance of ‘bluespace’ and the inclusion and management of waterbodies and watercourses. However, when working in parks the author found that the introduction of new water features sometimes raised concerns about safety, so it should be managed with care and with public consultation. For example, siting away from play areas and providing some sort of barrier, which might be a natural barrier such as a hedge.

Allotments were not considered scenic, ranking in the bottom three in all of the datasets and analyses. However, they perform important roles for urban residents, providing both exercise and healthy food, as well supporting ecosystem services such as pollination. The Department for the Environment Food and Rural Affairs (2016) list allotments as a key urban habitat for pollinators, supported by a broad range of plant species.

Scenicness is one aspect of amenity. There are various other aspects of amenity that are important in public greenspaces, some of which are unlikely to be considered scenic but that might contribute to people’s enjoyment; for example, the availability of facilities such as suitable paths, benches or litter bins. Greenspaces are required to fulfil many roles and to provide space for different types of use, and for a range of users, and often the provision of other ecosystem services, such as flood mitigation. Not all of these roles were considered scenic. For example, sports facilities are some of the least attractive of greenspaces' features, as demonstrated by this study. However, this does not suggest that they should not be provided, though in some cases perhaps there is scope to reduce their visual impact, for example by breaking up the vast expanses of closely mown grass of multiple sports pitches with hedges and trees.

The scenicness scores were all from an online platform and users were self-selecting. This means that their opinions are not necessarily representative of the general population. They may also not all have understood the term 'scenic' in the same way.

Looking at an image on a computer screen differs from experiencing a view first-hand or from using a greenspace. As the Scenic-or-Not images are taken out of context this may also affect the score, for example a woodland in a city may feel unsafe compared to a rural woodland if visited in person, but this will not be reflected in the score as the viewer is not aware of where the photograph is taken when they assign their score. It is possible that some Scenic-or-Not participants may recognise the location in the image, for example if it is their local park, and their knowledge of the location may affect the score that they give. Further study could include comparing people's scores of views from images to their scores if viewed in person.

The key categories of parks and more natural greenspaces, were found to be not significantly different. This does not necessarily mean that they were the same, but that any difference cannot be demonstrated statistically. This means that it was not possible to demonstrate where categories of greenspace were rated similarly, only when they were significantly different.

The size of the greenspace where the photo was taken has an effect on its scenicness, estimated here as a rate of 0.2 points per km^2. Images from larger greenspaces were found to be more scenic, though the effect is fairly small in this dataset. Small spaces such as compact 'pocket parks' are useful, particularly where space is at a premium, but local authorities should ensure that larger open spaces are available to residents so that they can enjoy open views and access to areas away from road noise and pollution.

There is not a clear north/south or east/west pattern in scenicness in greenspaces. In the original scenicness data, with images included that were not taken in greenspaces, there is more of a clear spatial pattern. Greenspaces tend to be amongst more scenic locations, regardless of their location. Of the Euro Regions, Scotland has the highest scoring greenspaces and London the least. This is likely due to Scotland's mountainous and rural nature, providing more scenic views in comparison to London's very built-up and urban nature. However, whether the greenspace was located in a major town or city or not only had a small effect on scenicness. Lessening the effect of urban views by screening with vegetation and opening up more scenic vistas would help increase the scenicness of greenspaces.

4.7 Conclusion

Crowdsourced ratings of scenicness of images from Scenic-or-Not were matched to maps of public greenspace. More natural types of greenspace were considered more scenic, so less intensive naturalistic styles of management could save costs and have a positive impact for park users and nature. However, some less attractive uses are important for people's enjoyment and other ecosystem services, for example allotments and sports grounds.

As photographs taken in larger greenspaces were rated as more scenic this suggests that it is important that people have access to wide open spaces.

Greenspaces in built-up areas were also slightly less scenic. Using vegetation to screen man-made features might help to reduce this effect, but care must be taken not to obscure sightlines through the site, as this could affect feelings of safety. Spatial patterns were less pronounced in the greenspace subset of Scenic-or-Not data than for the whole dataset with all images, including those not taken in a greenspace.

Users of Scenic-or-Not rated the scenicness of images located in greenspace which featured more natural views higher than those which were man-made. This demonstrates that people have a preference for natural views over built ones. Whilst scenicness is only one aspect of amenity, and other important facilities and services which greenspaces provide must also be considered, greenspace managers should aim to provide natural views in the spaces that they manage for visitors' enjoyment. This could include promoting more naturalistic styles of management. Planners and policy makers should also support the provision of greenspace which is attractive to park users.

Human preferences for specific greenspace maintenance and management styles are investigated further in the following chapter.

5 PUBLIC PREFERENCES FOR DIFFERENT TYPES OF HABITAT/MANAGEMENT TYPE

5.1 Background/Introduction

As outlined in the previous chapters, under ongoing UK government austerity measures, park and greenspace maintenance and management are changing; in particular types of floral display and frequency of grass mowing are being altered. The study described in this chapter assessed people's preferences for different management approaches to investigate the effect that changes in them might have on people's enjoyment. This follows the research into scenicness described in Chapter 4, which focussed on a crowd-sourced assessment of the attractiveness of images taken in greenspaces. Here, further detail on people's preferences in greenspaces and the maintenance and management of them is investigated through an online survey. This chapter also links to the research into pollinators' preferences for floral bedding of Chapter 3 and uses photographs taken during that study so that it can develop a basis for examining whether the preferences of people and pollinating insects are aligned. This alignment is important because it will enable park managers to make management choices which support other ecosystem services in addition to human enjoyment.

Many park managers are opting for cheaper perennial bedding over regularly replanted seasonal bedding as a way of reducing costs (Association for Public Service Excellence, 2018). This study uses images from parks in Coventry where much of the bedding has undergone this change under austerity, while some high profile sites are still managed as before. This chapter investigates whether this change is likely to have an impact on people's enjoyment. For example, regular replanting may mean that seasonal bedding is enjoyed throughout the year and that perennial bedding is less attractive early in the season.

Annual ‘meadow’ style plantings such as ‘Pictorial Meadows’ are also increasingly used in greenspaces, as well as in other locations such as on roundabouts and the central reservations of roads; this reduces the area requiring regular mowing and provides colour. This chapter investigates whether people like this new style of planting and how it compares to the other types of floral display.

Reducing the frequency with which grass is mown is another potential way of reducing costs that is being trialled in greenspaces. Thus people’s preferences for different grass length is of interest. Whether people like traditional striped mowing, plain short grass or longer grass is investigated in the current study.

Online surveys were carried out using photographs taken at the same sites in Coventry that were used for the preliminary part of the pollinator study in 2017. The results were used to assess people’s preferences for formal or natural greenspaces and for different styles of grounds maintenance.

5.2 Study Question/Aim

The study described here investigated people’s preferences for greenspace management approaches, in particular with regard to mowing and floral displays. This research was especially timely as austerity may lead park managers to save costs by making changes to the management of greenspaces . The aim is to identify any impacts of potential changes to park management, which might be made to save costs, on people’s preferences.

Specifically, this chapter addresses the following research objectives, also outlined in the introduction to the thesis (Section 1.3):

> RO4. Investigate the effects of different management practices on amenity value.

RO5. Investigate possible trade-offs between management practices that support biodiversity and other aspects of amenity.

Specifically, these objectives were investigated through examining human preferences for different floral display and for mowing regimes. These human preferences were then compared to those of pollinators in Chapter 3.

This study builds on the study of scenicness (Chapter 4) which examined people's preferences at the landscape scale, across Britain, but examines preferences at a finer scale. The current chapter specifically examined approaches to park maintenance and management regimes in relation to floral displays and mowing of grass, in the same areas where pollinators have been studied.

5.3 Previous research on landscape and management preferences

A number of studies have investigated people's preferences for broad landscape types and features, but few have looked at very specific features and the maintenance of parks and greenspaces, such as flower beds. Dobson *et al.* (2019) point out that there is "little evidence in the peer-reviewed literature of the wider social effects of specific interventions (such as the provision of a new café or different horticultural approaches)." In this section, literature is reviewed which examines preference at the landscape or park/greenspace scale in relation vegetation density, naturalness and biodiversity. A small number of studies were available which investigate specific management practices, such as flower bed planting and mowing, which is the focus of the current study. These are reviewed below.

The literature outlined below includes a range of studies that have investigated people's preferences for different types of landscape. Eight of these studies employed surveys based on the use of photographs. One study used "visitor employed photography", where the subject take photographs and describe them. Two studies used interviews conducted on site. Another study was based on structured interviews of greenspace managers. Three of the studies investigated specific features/management, namely meadows and planting styles.

Understanding preferences for formal or natural landscapes has been of interest to researchers for many years. Taylor, Zube and Sell (1982) describe how an upsurge in new legislation relating to landscape conservation in the 1960s and 1970s, such as the establishment of national parks in the USA and UK, was a key driver for a proliferation of research into scenic beauty and amenity. An early example of a study applying these principles to urban parks and forests is Schroeder's (1982) study. Schroeder found that when participants described images of urban forests and parks from Chicago, they most often mentioned that they preferred “natural features such as trees, grass, and water” over features such as “man-made objects, problems with vegetation, and poor maintenance”. This study concluded that man-made features and poorly managed vegetation detract from people’s enjoyment of parks and forests.

More recently, in an Australian study by Harris *et al.* (2018), a survey using photographs and was posted to selected respondents. The study found that respondents preferred densely-vegetated landscapes. This was in contrast to the authors’ expectations, since they anticipated that dense vegetation would have a negative impact on perceptions of safety. Using Principal Components Analysis to group by preference score, the authors identified four primary landscape components which they referred to as “dense”, “open”, “suburban garden” and “English landscape”. Open landscapes were the least favoured of the four landscape components identified by their study. They found that the proportion of lawn in an image had a negative effect on people’s preference; the other landscape components, with a more complex vegetation structure, were preferred. Harris *et al.* (2018) used photograph editing software to edit the brightness of images taken in overcast conditions, which can introduce risks, as altering brightness could significantly change the colours within in the image. Altering the colours in the image would be particularly problematic in the current study, where the photographs of flowers contain a range of colours which could themselves be influencing preferences.

In a Norwegian study, using a postal survey which also included five photographs representing a range of vegetation densities, Bjerke *et al.* (2006) found that “moderately dense scenes received the highest preference ratings.” The studies undertaken by Harris *et al.* and Bjerke’s suggest a preference for dense/complex vegetation; this is somewhat contrary to traditional views on human preference for open views, such as the “*Prospect Refuge Theory*” (Appleton, 1975, 1984), which suggests that, for evolutionary reasons, people prefer “edge” habitats providing refuge with access to open views. Prospect Refuge Theory has been used to imply that people prefer the traditional ‘mown grass with lollipop trees’ paradigm in parks management. For example, Gobster (1994) and Falk and Balling (2009) describe a preference for savanna type habitats, wide open spaces with occasional trees or shrubs. However, Harris *et al.*’s and Bjerke’s studies point to a preference for greater density of vegetation suggesting lower preference for mown grass with occasional trees.

In Sweden, Qiu, Lindberg and Nielsen (2013) used ‘visitor-employed photography’ where participants took photographs of features within their study site (Ramlösa Brunnspark in Helsingborg) and “briefly describe[ed] the photo content and motivation for taking it”. The study found that “lay people” (who did not have expertise in relation to biodiversity) can recognise biodiversity and species richness when compared to the authors’ own assessment of the habitat. There were differences between the opinions of “experts” and “lay people” who participated in the study. For example, experts saw dead wood as positive and lay people saw it as negative. Preference had a negative correlation with biodiversity, though the authors point out that certain features affected preference, for example water features were “appreciated” by participants, but not when they appeared obviously man-made. The study by Qiu, Lindberg and Nielsen (2013) aligns more closely with Prospect Refuge Theory (Appleton, 1975, 1984), as they found that semi-open areas, for example mown lawns with scattered trees and shrubs, were preferred. Qiu, Lindberg and Nielsen (2013) state that “negative preferences for … richer habitat types were mostly related to the presence or execution of human interventions”, which suggests that the design and maintenance of the greenspace had an impact on preference. The study by Qiu *et al*. was relatively small, comprising 67 respondents who visited one site and with 10 photographs taken by each respondent. Also in Sweden, using a postal survey sent to residents close to the greenspaces included in the study, Sang *et al.* (2016) found that urban green spaces that were perceived as more natural had “a greater value for experience, activity, and wellbeing”. In a subsequent publication the same authors examined this postal survey further and found that “aesthetic perceptions of green spaces” correlated positively with field measures of biodiversity (Gunnarsson *et al.,* 2017). The suggestion is that human preference may correlate with naturalness and biodiversity. Similarly, Hoyle, Jorgensen and Hitchmough (2019) found positive correlations between perceived naturalness, perceived biodiversity and aesthetic appreciation. Hoyle, Jorgensen and Hitchmough (2019) found a negative correlation between perceived naturalness and tidiness.

To compare people’s preferences in formal and naturalistic landscapes Özgüner and Kendle (2006) employed an on-site survey in Endcliffe Park (largely naturalistic) and the Botanical Gardens (largely formal), both in Sheffield in the UK. A random sample of visitors were questioned at each site, but the survey was only continued with those who were familiar with both sites. Özgüner and Kendle found that the public generally understood the difference between manicured and naturalistic landscapes and that they enjoyed both, and gained benefits from both, and some of the benefits overlapped between naturalistic and formal landscapes. Respondents’ understanding and opinion of what constitutes a ‘natural’ versus ‘managed’ landscape varied, for example 23% describe the Botanical Gardens as ‘natural’, but participants generally related greater human intervention with reduced naturalness. More natural elements tended to rank high in their lists of ‘liked features’ at both sites, and man-made features come towards the bottom. Notable man-made features such as benches and paths came towards the middle of both parks’ lists of ‘liked features’. One might presume that this is because, whilst not necessarily attractive, these aid people’s access to and enjoyment of the sites. Greenhouses and neat lawns featured high on the Botanical Garden’s ‘liked’ list; this is a more formal site so this may be what people expect there. The greenhouses are manmade features which may be considered attractive in their own right, and are also filled with interesting natural features in the form of exotic plants. Though visitors mentioned lawns and flower beds, specific management styles were not investigated. As Özgüner and Kendle studied two sites in a single city, further examples would confirm the applicability to greenspaces in general.

Peoples’ choice of a greenspace to visit can be driven by convenience, for example Shanahan *et al.* (2015) found that participants in an online survey in Brisbane, Australia, tended to choose the parks to visit based on proximity to home rather than vegetation cover, except for people with an interest in nature who would travel further to visit parks with more vegetation. The authors suggested that education or social interventions would enhance people’s connection to nature and therefore the benefits they receive from “ecologically valuable spaces” (Shanahan *et al.*, 2015).

More recent studies have considered more specific features and management types and these offer a more detailed insight into the impact of greenspace management interventions. For example, Southon *et al.*'s (2017) study used experimental meadow plots in southern England and asked greenspace visitors to score photographs. The authors found that their participants preferred the study’s experimental plots to formal flower beds, herbaceous borders and mown grass. Southon *et al*. pointed out that other commentators (Gobster, 1994; Nassauer, 1995, 2011) had suggested that naturalistic vegetation may be inappropriate in urban areas as it could be considered "disordered and scruffy" therefore it may be perceived as 'messy' or under-managed by greenspace users. However, Southon *et al.* (2017) found that people are "receptive to the idea of naturalistic vegetation in urban green-spaces". The current study focusses on existing management approaches carried out by local authority parks departments, rather than experimental plots, to assess the impact of 'real world' examples.

As part of her doctoral thesis, Hoyle (2015) carried out site walks and interviews with visitors in woodland, shrub and herbaceous styles of planting in Sheffield. Hoyle found that the plantings considered the most attractive were those that represented "a taming of 'wild' nature to make it look to some degree 'cared for'". Flowering and colour elicited positive reactions, though participants also enjoyed more subtle colours, such as the greens providing the "background", meaning that people can enjoy vegetation when it is not in flower. Interviewees also understood the value of some of the study habitats for wildlife. For example, they understood the value of habitats for insects and the fact that insects are an important element of the ecosystem.

In a later work, Hoyle *et al.* (2017) used semi-structured interviews to investigate the views of the eight park managers who had been involved in their project to trial meadows in urban greenspaces. They found that the level of support for the introduction of meadows depended on the managers' own interest in nature. Park managers also understood that the general public's increasing interest in nature was leading to greater acceptance of a "messier urban aesthetic". The current study builds on this as it investigates whether this "acceptance" and increased interest in wildlife translates into a greater preference for more naturalistic floral displays and relaxed mowing when compared to traditional flower beds and closely mown grass amongst the respondents to the survey carried out for the current study. Hoyle *et al.* (2017) also point out that the challenges in implementing greenspace management changes are not simply technical, they are also "political, strategic, economic and practical". An example of these challenges is the encouragement of park managers to accept new styles of management. Obviously, cost effectiveness is a possible motivation which would help with their acceptance.

Nam and Dempsey (2019) investigated public acceptance of formal bedding, meadows with wildflowers and long grass. Their survey focussed on community groups, park professionals and residents in the vicinity of six Sheffield parks. The survey of residents found that the level of acceptance of the various features varied between the survey sites. Acceptance of formal bedding and meadows with wildflowers was generally high. A higher proportion of residents stated that they "could see" formal bedding in their park than the proportion who could see meadows with flowers in four of the six parks. A greater number of residents also stated that they felt formal bedding "could contribute to better park management" in their park than meadows in four out of six parks. Though there is variation with local context, formal bedding was generally met with higher acceptance than meadows with flowers.

The current study includes seasonal bedding and Pictorial Meadows, which are similar to Nam and Dempsey's floral display categories, as well as perennial bedding, which is more naturalistic than formal bedding but closer to it in form than meadows. In Nam and Dempsey's (2019) study, acceptance of long grass was lower than acceptance of the floral features for all but one of the parks; acceptance of long grass also varied between sites.

The studies described above demonstrate that people often prefer natural features to manmade features, but that the quality of human interventions, such as maintenance and design, are also important. Acceptance of, or preference for, natural and complex vegetation types was high. Results differed between the various studies, for example Qiu, Lindberg and Nielsen (2013) found a negative correlation for people's preferences with the naturalness of the landscape, but the other studies found a positive relationship for people's preference and naturalness, biodiversity or complex vegetation structures. The current study does not investigate vegetation complexity directly, though preferences for different mowing styles were examined. Table 11 gives a summary of the literature.

Table 11: Summary of findings of literature review

Author(s)	Respondents preference	Other findings
Dobson *et al.* (2019)		Little evidence of social effects of interventions
Taylor, Zube and Sell (1982)		Legislation in 1960s and 1970s led to increased research on landscape
Schroeder (1982)	"Natural features"	
Harris *et al.* (2018)	Densely-vegetated landscapes.	
Bjerke *et al.* (2006)	"Moderately dense scenes"	
Appleton (1975, 1984),	"Edge" habitats	
Gobster (1994)	Savanna	
Falk and Balling (2009)	Savanna	
Qiu, Lindberg and Nielsen (2013)	Negative correlation preference with biodiversity	Preference depends on quality of interventions
Sang *et al.* (2016)	If perceived as natural, greater value for visitors	
Gunnarsson *et al.* (2017)	Positive correlation aesthetic perception with biodiversity	
Hoyle, Jorgensen and Hitchmough (2019)	Positive correlations between perceived naturalness, perceived biodiversity and aesthetic appreciation	
Özgüner and Kendle (2006)	Natural features to manmade	People gain benefits from both formal and natural landscapes
Shanahan *et al.* (2015)	Convenience (proximity)	
Southon *et al.* (2017)	Prefer meadow (to beds, borders and mown grass)	
Gobster (1994) and Nassauer (1995) (cited in Southon *et al.* 2017))		Naturalistic vegetation is inappropriate in urban areas
Hoyle (2015)	"Taming of 'wild' nature"	
Hoyle *et al*. (2017)		Park managers acceptance of meadows depends on interest in nature
Nam and Dempsey (2019)	Acceptance of both formal beds and meadows high (formal beds often higher)	

While the majority of the studies considered preference at the greenspace level, four of the studies investigated people's preferences for specific management types (Hoyle, 2015; Hoyle, *et al.*, 2017; Southon *et al.*, 2017; Nam and Dempsey, 2019). This study takes this aspect further by investigating real examples of new management practices implemented by the managers of greenspace, and what people's preferences were for these when compared to traditional management. The current study aimed to discover the preferences of people. This was later compared with the preferences of pollinators. This demonstrates whether people prefer the same park features and management as this particular aspect of biodiversity.

5.3.1 Literature informing the methods in this study

This study employs an online questionnaire with photographs of park features. Photo-based methods are a well-established method for assessing people's preferences for landscapes, though they do have some limitations. For example, Schroeder (1982) used images from Chicago to solicit participants' responses to landscape features and management. Steen Jacobsen (2007) claimed that "the employment of photographs is basically regarded as a valid surrogate for the real landscape in the context of sightseeing and similar tourist experiences". Steen Jacobsen (2007) also pointed out that the use of photographs offers greater control over the way that the questions are presented and other conditions, such as the weather. Another reason that photographs are particularly useful is that respondents can examine multiple and diverse landscapes, or features of them, side by side and in a short period of time. An equivalent on-site study would require visits to multiple locations within a site or travelling to additional sites, and so be very time consuming. For on-site surveys it is still often necessary to use photographs to allow the comparison of multiple features, as in Southon *et al.*'s (2017) study described above. Barroso *et al.* (2012) recognised the advantages of on-site assessments as they involve senses other than sight, which contribute to the experience. However, they stated that the "use of photos is generally favoured because it makes it possible to involve larger samples of observers, and it has been shown that judgments provided by photo surveys are close (correlation 80% or more) to those from on-site surveys”.

There are some drawbacks to using photographs as surrogates for visiting a location. On site experience does differ from viewing photographs. In Hull and Stewart's (1992) study 38% of participants showed statistically insignificant relationships between their on-site and photo-based assessments of scenic beauty. However, this suggests that the relationship was statistically significant in 62% of cases. It is not known whether the 38% of respondents who gave insignificant relationships between on site and photograph assessments would have given different opinions to those who had a significant relationship, and therefore it isn’t known how this would have affected the findings.

Implementing surveys over the internet can collect large numbers of responses with relatively low input from the researcher. Research relying on internet surveys must also consider the effect of distancing the respondent from the subject. Wherrett (1999) pointed out that whilst “there is substantial merit in using the Internet as a medium for executing visual preference research” there can be technological issues, for example, the size or resolution of screen used by the respondent. Roth (2006) considers internet surveys to be an objective and reliable method for collection of data on people’s perception of landscapes. Roth implemented an online survey on landscape preference which also collected demographic data and data about the respondents’ equipment (e.g. screen resolution). Also included were versions of the survey with different ways for users to input their rating. Roth found that the “technological and methodological configuration” of the internet-based questionnaire did not have an effect on the outcomes of their study.

As outlined above, photo-based surveys are considered a valid surrogate for a visit in person while providing greater control over the presentation of the features of interest. They are also economical. There are considerable time demands associated with showing even one respondent 30 examples of flower beds. In contrast, an online survey is scalable, with respondents able to view numerous photographs in a short period of time without the researcher being present or having to record data from face-to-face interactions.

Other methods could have been employed here, for example, observations of greenspace users, but their sentiments in relation to the features would be difficult to measure, for example what motivates them to use a particular site may just be its proximity to home (Shanahan *et al.,* 2015). Advancements in technology mean that good quality photographs are economical to create and an online survey is relatively straightforward to create and to share through e-mails and social media. Therefore, the decision was made to employ a photo photo-based survey method.

5.4 Method

This study is based on an online survey which uses images of types of floral display and mowing styles used in greenspaces, with questions about the respondents' characteristics and preferences. The online questionnaire was created using photographs taken by the author, as part of the preliminary part of the pollinator study (Chapter 3) (see Appendix 3.6 for the full survey). All of the photographs were taken with the rear camera of an iPhone 6, without flash. The pollinator surveys required specific weather conditions which were based on UK Butterfly Monitoring Scheme (UKBMS) guidelines (2006) which stipulate that the weather should be warm and at least bright with no more than moderate winds, there should be no rain and the temperature should be either 13-17^{o}C with at least 60% sunshine, or if there is no sunshine, 17^{o}C or above. A handheld anemometer was used to check windspeed and temperature during the pollinator surveys. Therefore, the images were all taken on bright, still days in spring and summer which increases their comparability. As the photographs were all taken by the same person, with the same camera and in similar weather conditions, this reduces any effect that the image quality may have had on the survey results. Use of images from a single source improves on studies using images of varied provenance, including those used in the previous chapter (Chapter 4). It also means that minimal editing of the images was required.

The photographs used in the survey were selected from all of those taken in the previous study by first removing any which did not show a good portion of the flower bed and then selecting from each bedding type in the date/time order that they were taken. Selecting the photographs in this way minimised investigator bias so that preferred images of a particular type of bedding were not selected. Where the image contained a significant proportion of the immediate surroundings or background it was cropped to remove them, but, where appropriate, a small amount of the surrounding vegetation was retained, for example a small border of mown grass to show the edge of a flower bed and show the extent of the feature.

It is important to note that images were restricted to Coventry and the land was managed by either Coventry City Council or the University of Warwick. As such, the findings may include effects that are specific to sites, managers or other regional factors.

Three types of floral display were represented in the images: 1) seasonal bedding, 2) perennial bedding and 3) "Pictorial Meadows". Plants in all three of these floral displays were chosen by site managers for their ornamental value and they were based predominantly on non-native species. Seasonal bedding is replanted two or more times per year with plant species. The photographs include a range of species such as begonias (*Begonia spp.*) and zonal geraniums (*Pelargonium spp.*). Perennial bedding, sometimes called sustainable bedding, is not regularly replanted the images include plant species such as Lamb's Ear (*Stachys byzantina*) and Verbena (*Verbena bonariensis*). "Pictorial Meadows" produce a range of proprietary seed mixes;

in the case of this case study, the “Classic” annual mix (Pictorial Meadows, 2017) was planted by the local authority. The photographs includes species such as Phacelia *(Phacelia campanularia)* and Black-eyed Susan *(Rudbeckia hirta).*

The images of floral bedding were further subdivided into ‘early’ images taken in May and early June, before the bedding was in full bloom, and images when the beds were in full bloom to allow comparison of people’s preferences at different stages of the flowering cycle.

Grass is also a key feature of urban greenspaces and the regularity of mowing is a major aspect of the greenspace management. Three types of mowing were included in the survey, short/regularly mown, formal grass mown into stripes, and long/infrequently mown grass. Fewer photographs were available from the pollinator study for this element of the survey, so fewer questions where included on this topic and, therefore, this was not examined in the same depth as floral displays.

The questions based on photographs included ‘Likert’ questions, where respondents rated each image “dislike a lot”, “dislike a little”, “neither like nor dislike”, “like a little” or “like a lot”, to determine respondents’ preferences. This method of measuring attitudes was developed by Rensis Likert (1932). The rank questions asked the participants to sort the three types of bedding or mowing into order of preference. In both cases, each question contained an image of each type of bedding or mowing.

The survey was released online between July 2018 and July 2019. It consisted of 33 questions, each appearing on its own page within the Qualtrics platform. The first section consisted of 7 questions “Please rate the photos below”, of which 6 featured a photograph of each of the 3 types of floral display and one featured the 3 types of mowing. There was a range of 5 Likert style responses from “Like a lot” to “Dislike a lot”. The first section also included 8 questions where the respondents ranked the photos in order of preference, 6 of these featured the 3 types of floral display and 2 featured the 3 mowing regimes. Figure 65 shows examples of the photographs in each category.

Figure 65: Example photographs of each type of bedding and mowing style included in the survey. The "early" images were taken in May and early June before the bedding was in full bloom.

The rank and Likert style questions in the first section appeared a random order. Two free text responses on what respondents liked and disliked in the images followed the first section as did 2 questions on whether the respondents choice would change depending on cost and value for wildlife. A question with 5 answer choices ranging from "strongly agree" to "strongly disagree" featured sub-questions on peoples preferences for grass length, encouraging wildlife, formal features and natural features. There were questions on the frequency that the respondent visited parks and the purposes of their visits, as well as how often they visit rural areas. Respondents were asked about whether they were interested in wildlife, whether they live in an urban or rural setting and the type of work they do or did. They were also asked their age, gender and home postcode. See Appendix 3.6 for the full survey.

5.4.1 Survey design

The description of the survey design provided below is based on CHERRIES, *The Checklist for Reporting Results of Internet E-Surveys* (Eysenbach, 2004). This reporting framework assists in providing the reader with a good understanding of survey design and any possible bias (Eysenbach, 2004). The checklist was designed for web-based surveys, in particular for health research, but the principles of good questionnaire design and reporting are transferable to surveys in other domains.

The survey was an open online survey using a self-selecting sample of respondents. The survey was promoted through Twitter, Facebook, e-mails to the investigator's contacts, and posters on park notice boards in the West Midlands. The survey was also promoted through the survey sharing website SurveyCircle (www.surveycircle.com). The survey was designed and implemented online using the Qualtrics (2019) platform (https://www.qualtrics.com).

Ethical approval for this study was sought through internal departmental procedures in the Centre for Interdisciplinary Methodologies (CIM) at the University of Warwick, as participation was deemed to be 'low risk' for respondents. There were no data protection issues as no identifying personal data were collected. To gain the informed consent of participants the first page of the survey provided information on the length of survey, use and storage of data, contact details of the investigator and purpose of study, and participants then ticked to confirm they were happy to proceed. No incentives were offered to participants.

The survey was tested by the investigator's supervisors and colleagues for functionality and to check that the questions were easily understood, before being shared more widely. It was suggested that using a random order of questions and displaying only one question per survey page would reduce the effects of context between the similar questions, for example seeing other images of the same type of bedding at the same time might affect responses (James Tripp pers. com, 2018). These changes were implemented before the survey was shared more widely (through social media etc. as described above). The main body of the survey featured questions based on photographs, and both the order of these questions and the order of the photographs within each question were randomised as well as the order of the response options, to reduce bias.

The question at the beginning of the survey seeking agreement to take part was the only mandatory question and all others could be skipped and respondents could leave the survey at any point. Back buttons were available on all pages in case the respondent wished to re-visit the answer to a previous question. To ensure the anonymity of the participants IP addresses were not collected. Because of this there was the possibility that repeat entries could be made by the same respondent.

Between July 2018 and July 2019, a total of 407 responses were received of which 244 were complete, with no questions unanswered. Initial summary analyses used all of the responses, including those which were incomplete. Statistical analysis used only the surveys that were complete.

The shortest time taken by a respondent to complete the survey in full was 120 seconds. The shortest incomplete survey took 8 seconds to complete. Some users clearly left the survey and came back to complete it later as the longest time taken was 1,221,956 seconds (14 days 3h 25m 56s); this very long interval increased the mean time taken to complete the survey 5113 seconds (1h 25m 13s). Omitting this extreme result reduced the mean time taken to 2093 seconds (34m 53s).

Demographic data collected in the survey were used to investigate the effects of gender, age, whether the respondent lives in an urban area, and frequency of park visitation, on responses to the main survey questions. Data relating to attitudes to nature and park management were collected. See Appendix 3.6 for the full survey.

5.4.2 Analysis

Data were visualised and analysed using the R statistical computing language (R core team, 2017). Initial graphs that were prepared include the complete dataset, including the records with missing values. Full analysis includes only the surveys that were complete as data analysis is more robust when there were no missing values, and an investigation of relationships with demographic factors was only possible for those respondents who had carried on to the end of the survey where these data were collected.

5.4.2.1 Regressions

Linear regressions were carried out with the complete surveys (N=244) to investigate people’s preferences for the various floral displays. Their answers to demographic questions and the other questions relating to their attitudes and preferences were also included in regressions. For all of the regressions, residual plots were created, these showed that the assumptions of linearity and homogeneity of variance were met, since residuals were approximately normally distributed and no values were exerting excessive leverage (Cook's Distance).

5.4.2.2 Colour

To investigate whether the colours in the images influenced preference, the Colordistance package (Weller and Westneat, 2019) was used to extract and analyse colours using pixel binning. This method converts the colour into red, green and blue colour channels (RGB). A colour channel stores information on a primary colour component of a pixel (in this case the amount of red, green or blue). For pixel binning each colour channel is divided into ranges of equal size. The combination of ranges from each colour channel forms a 3 dimensional "bin". With 3 colour channels, the number of 3D bins is the cube of the number of bins chosen. If we use 3 bins for each colour channel this gives us 3^3 which results in 27 bins. Alternatives would be 2^3 giving 8 3D bins or 4^3 giving 64 3D bins. Using 8 3D bins lacked detail and missed a lot of less common colours in the image, and with 64 3D bins a lot of the RGB channels contained very few pixels. The resulting colour profiles were visualised as 3D plots using scatterplot3D (Ligges and Mächler, 2003).

A complementary analysis was performed in the Colordistance package using K-means clustering. In this analysis, the number of clusters set by the user and the algorithm assigns all pixels to clusters in such a way that the sum of the distances between datapoints and the centres of the clusters to which they are assigned is minimised. K-means were set at 27 clusters to allow easy comparison of the plots from the 2 methods.

Using the same package, colour distance plots of the difference between the colours in the binned histograms of each of the images, were created. Measurement of the difference between the colours was based on earth mover's distance (EMD). EMD uses the minimum amount of "work" to transform the distribution of the colour histogram from one image to that of another (Weller, 2019). The amount of "work" depends the size of the changes (magnitude of difference in the colour) and the number of changes required to be made. A greater difference between the histograms creates a relatively higher "cost", so this gives a measure of difference between the images (Weller, 2019).

5.4.2.3 Text analysis

In order to investigate the reasons for people's preferences, plots of the co-occurrence of words in the free text questions 'Please briefly explain what you liked in the pictures in the survey so far' and 'Please briefly explain what you disliked in the pictures in the survey so far', were created in the R package 'udpipe' (Wijffels, 2017). Co-occurrence is used here to identify themes in the answers to these questions. Lancia (2007) describes the aims of analysis of word co-occurrence as finding "similarities in meaning between word pairs and/or similarities in meaning among/within word patterns, also in order to discover latent structures of mental and social representations."

Rapid Automatic Keyword Extraction (RAKE), is an algorithm which identifies key words, or sequences of words, in text, from the R package 'udpipe' (Wijffels, 2017). RAKE was used to extract keywords from the free text questions 'Please briefly explain what you liked in the pictures in the survey so far' and 'Please briefly explain what you disliked in the pictures in the survey so far.' The keywords were then checked manually in the original dataset to ensure that the sentiment was assigned correctly.

RAKE removes stop words (e.g. 'and', 'it', 'the') to create a list of words which are split by the delimiters (punctuation) and stop words. Thus, a list of "candidate expressions" (both individual words and short phrases) is created. RAKE then creates a matrix and scores constituent words by dividing the number of times each co-occurs with each of the other words by the number of times it appears. The “candidate expressions” were also given a score based on the sum of the scores of the constituent words.

It is possible that some of the keywords extracted could have the opposite meaning to the respondent’s intended answer. For example, in the ‘likes’ question, a participant might state “I like natural flowers better than traditional bedding”, “traditional bedding” may be selected as keyword and we might surmise that it is a feature which people liked. To check whether this was the case, all of the instances of the RAKE selected keywords were manually checked in the dataset.

5.4.3 Scales created from Likert items

A ‘Likert item’ is a single question using a scale of agreement (Likert, 1932). One potential issue with analysing responses to Likert items is that the data are ordinal and one cannot necessarily assume that the answer options are equidistant. For example, the distance between ‘like a little’ and ‘like a lot’ may be different to the distance between ‘neutral’ and ‘like a little’. As a result, it is not necessarily correct to numerically code the items and treat them as interval data (Kuzon, Urbanchek and Mccabe, 1996; Jamieson, 2004). However, according to Johns (2010), Likert’s original argument was that “survey respondents actually construe the response scale in terms of evenly-spaced points along an underlying attitude continuum”. If we accept this argument then the Likert data may be considered to be close to interval data.

A ‘Likert scale’ is a collection of Likert items combined to give a respondent’s opinion on a range of similar questions. Combining multiple items also gives more accurate readings by covering multiple facets of the same attitude, for example preference for various examples of the same type of bedding. Scales also dilute “the impact of the ‘random’ error to which any individual item is inevitably subject” (Johns, 2010). Norman (2010) also points out that parametric statistics are actually quite robust with regard to violations of assumptions related to normality, and to the use of ordinal data as opposed to interval data.

Carifio and Perla (2008) suggest that it is rare that an analysis is based on a single Likert item, and also that it is usually not advisable. Carifio and Perla (2008) further assert that the debate on Likert scales and their analysis “clearly and strongly goes to the intervalist position, if one is analysing more than a single Likert item.” Their argument suggests that Likert scales can be treated as interval data, supporting the use of parametric statistics that Carifio and Perla (2008) maintain are more powerful and sensitive than non-parametric statistics.

Before combining the Likert items in the survey into Likert scales, it was necessary to test the internal consistency of these scales to ascertain whether the Likert items agree with one another. For example, do people who like one image of perennial bedding like other images of perennial bedding? Cronbach’s Alpha is one measure of internal consistency commonly used to test the reliability of scales. Some authors, such as Peters (2014), believe that Cronbach’s Alpha is an outdated measure of reliability whose assumptions are often violated. Peters states that Cronbach’s Alpha is “unrelated to a scale's internal consistency and a fatally flawed estimate of its reliability” and that it assumes that the items being combined into a scale are repeated measurements, which they often aren’t. Peters recommends other measures, including Omega and Greatest Lower Bound. In this study the Omega scores were also used and were very close to the Alpha scores, which increases confidence in the measures.

With the 244 complete surveys, the correlation of scores within each set of photographs (for example, all photographs of perennial bedding) was tested using ‘scaleReliability’ function from 'userfriendlyscience' package in R. This includes Cronbach’s Alpha, Greatest Lower Bound, Omega and Ordinal

Omega. This gives a measure of internal reliability to help decide whether the questions are suitable for combination into a scale.

There are no definitive limits for satisfactory scores when measuring internal reliability but Hair *et al.* (2000) suggest that Cronbach's Alpha scores of over 0.6 are acceptable for exploratory analysis. The Cronbach's Alpha score for the subset of photographs of perennial beds which were not yet in full bloom was low (0.14), probably due to the fact that there were only 2 photographs in each of the 'early' subsets of images. A lower number of items included in a scale can lead to a lower Cronbach's Alpha score: "increasing the value of alpha is partially dependent upon the number of items in the scale" (Gliem and Gliem, 2003). For all of the other subsets, all of the other scores (for Alpha, Greatest Lower Bound and Omega) were above 0.5, still quite low. Ordinal Omega and Alpha scores were higher, the data are ordinal so these measures are more suited to them. The scales for seasonal bedding and Pictorial Meadows had higher internal consistency than the scale for perennial bedding, this may indicate greater variability in the photographs of perennial bedding and, perhaps, in this style of management. The groups which combine all of the photographs in each type of floral display (including those not yet in full bloom and in full bloom) all scored over 0.6 for all three measures. The Figure 78 to Figure 86 and analysis below feature only these complete subsets (by bedding type) with 'acceptable' internal consistency. The 'early' subsets of images did not have sufficient internal consistency, so they were not included in the analysis.

Questions on attitudes to greenspace management and wildlife (e.g. "Wildlife should be encouraged", "Long grass is OK for most areas") were also combined into a scale and the Omega, Greatest Lower Bound and Cronbach's Alpha metrics were all over 0.7, indicating good internal consistency.

As outlined above the scores for these measures of internal consistency allowed the combination of Likert items into Likert scales by summing the preference scores; for example, summing the scores given by respondents for all of the images showing each of the types of floral display.

5.5 Results

5.5.1 Graphs utilising the whole dataset

The following figures, Figure 66 to Figure 77, are based on the complete data set (N= 407), including those with missing values. These initial graphs include all of the data, even where the respondent dropped out part of the way through the survey, this allows all of the data to be visualised but does not allow for statistical analysis. Statistical analysis is included later (Section 5.5.8 to 5.5.14) using the 244 complete responses. As demographic data such as age and gender were collected at the end of the survey the records with some missing data often did not include demographic data, so analysis of this in included only with the complete surveys. Data with no missing values also allowed the creation of scales from Likert items and allowed robust statistical analysis.

5.5.2 Which images of floral displays received high Likert preference scores?

The responses to the question "Please rate the photographs below, which show types of flower bed/floral display" are shown in Figure 66. Respondents preferred the beds that were in full bloom rather than the images taken early in the season (those titled "early", the top two rows of the graph), especially in the case of seasonal bedding. One potential advantage of seasonal bedding is that it provides a long flowering period due to regular replanting, although this seems not to be reflected here in the preference scores. Perennial bedding had the most positive responses for the "early" bedding images, which were not yet in full bloom. Pictorial Meadows are regularly re-seeded and are not in flower early in the season. The lower rankings of the 'early' photographs of Pictorial Meadows when compared to perennial beds in may have been related to this lack of flowers early in the season. Pictorial Meadows were ranked highest when in full bloom, followed by perennial bedding in full bloom. Seasonal bedding did not receive the greatest number of positive scores in any of the questions.

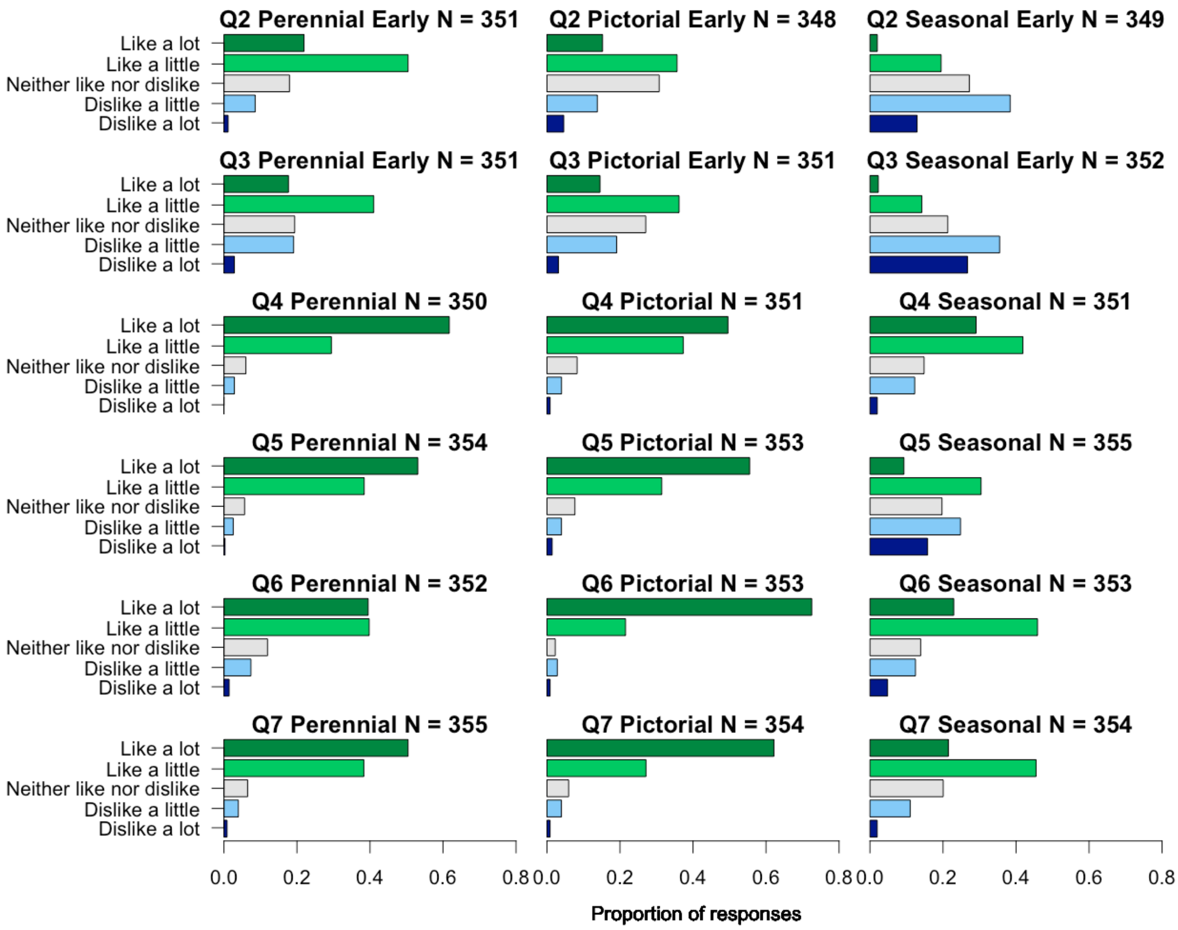


Figure 66: Likert survey responses to images of different types of floral bedding, by individual question/image. "Early" denotes early in the season before flowers are in full bloom. Each row of this graph represents one question in the survey, three images of different types of floral display were shown together. Each small graph represents one image hence there are multiple graphs for each category.

5.5.3 Which images of mowing regimes received high Likert preference scores?

The responses to the question "Please rate the photos below, which show types of grass/mowing" are shown in Figure 67. Images of long grass received the most "like a lot" responses. Short grass had the most "like a little" responses and it also received very few "dislike a lot" responses, so it was also liked by many respondents. The responses to 'Striped mowing' were the most polarised, with a lot of the responses being either side of neutral; some people like this very formal style of mowing, others dislike it.

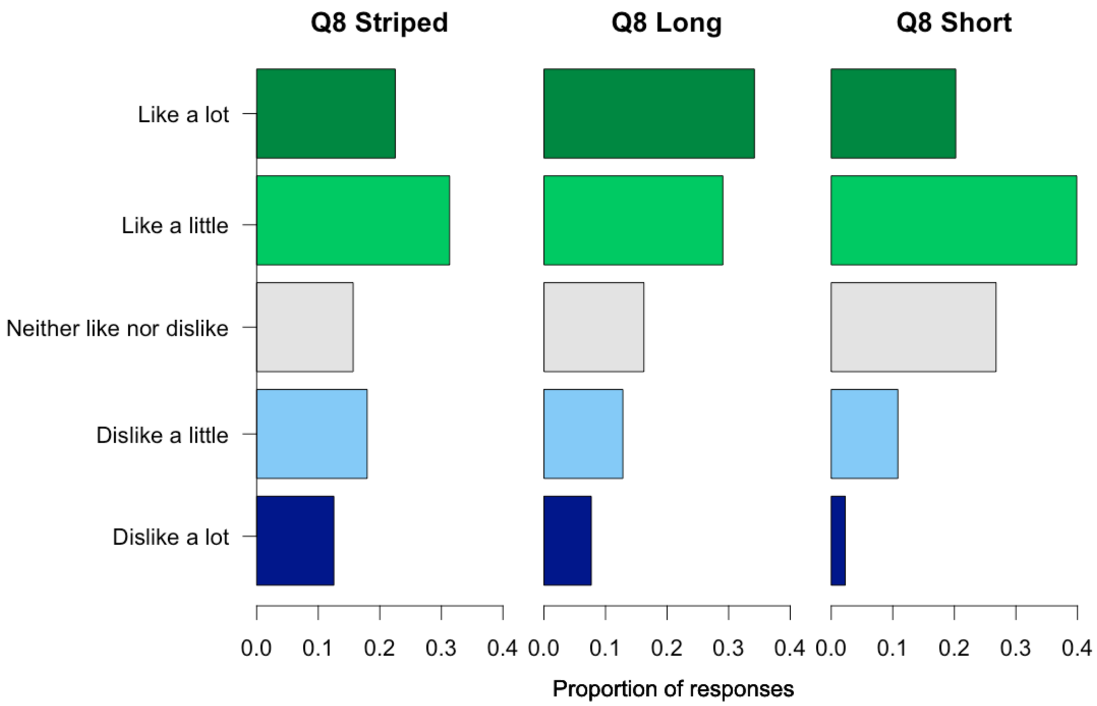


Figure 67: Likert survey responses to images of various types of grass mowing regime. Each of the smaller graphs (columns) represents one image. N=351

5.5.4 How did respondents rank the images of floral displays?

The rank style questions required the respondents to choose between the types of floral display and place them in order of preference. This differs from the Likert questions where respondents could indicate that they liked or disliked all of the images in a question. When the respondents were asked to "rank the following photos, which show types of flower bed/floral display. 1 being your favourite, 3 your least favourite" (Figure 68) seasonal bedding ranked third more often than the other bedding types in all of the individual questions. In common with the Likert questions, perennial bedding scored high "early", when not in full bloom, but Pictorial Meadows tended to rank higher when in full bloom. In a similar pattern to the Likert answers, seasonal bedding tended to rank third most often both early in the season and when in full bloom.

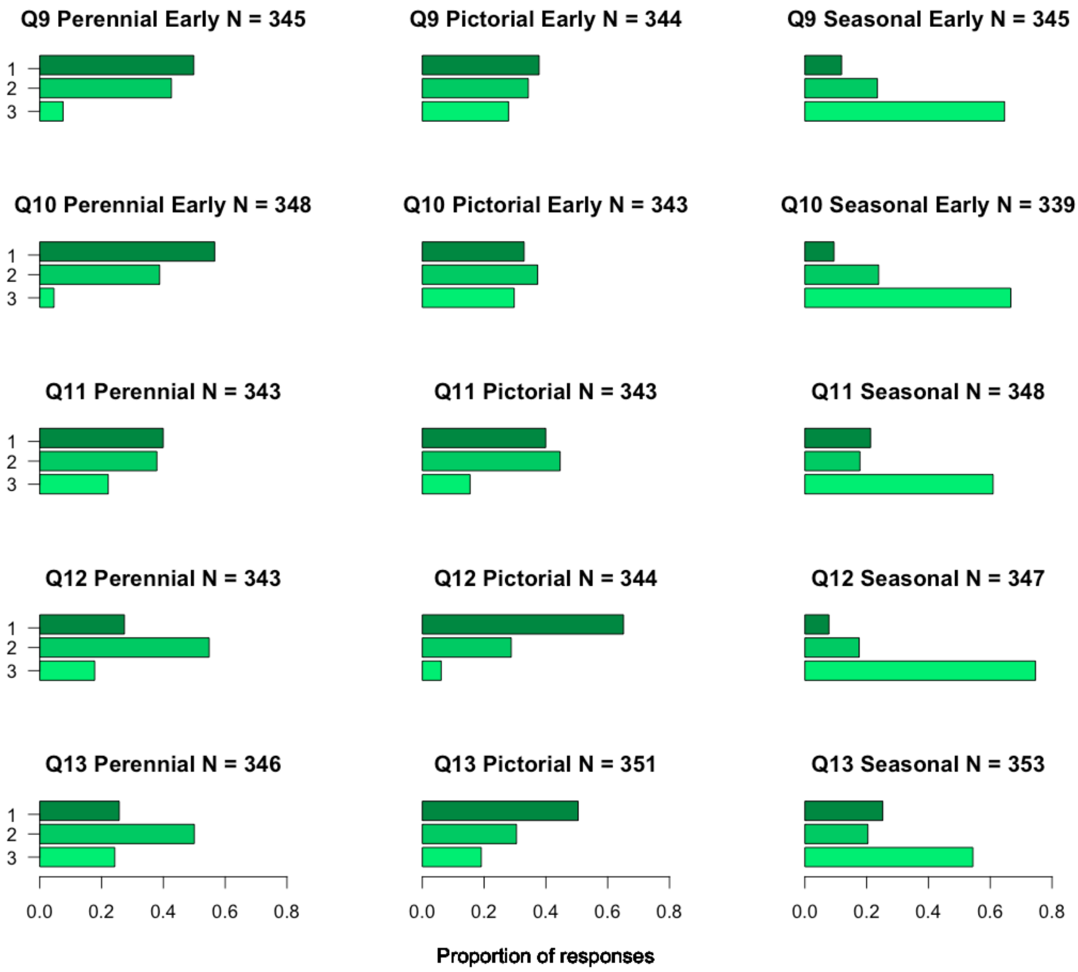


Figure 68: Ranks assigned by respondents to images of floral displays, by question. 1 is the most preferred, 3 the least. "Early" denotes early in the season before the flowers are in full bloom. Each row of this graph represents one question in the survey, where three images of different types of floral display were shown together. Each small graph represents one image.

5.5.5 How did respondents rank the images of mowing regimes?

When respondents were asked to “rank the following photos, which show types of grass/mowing. 1 being your favourite, 3 your least favourite”, long grass was the most preferred in both questions. Striped mowing ranked third most often in question 14 (the top row in Figure 69), and short mown grass ranked third most often in question 15 (the bottom row in Figure 69).

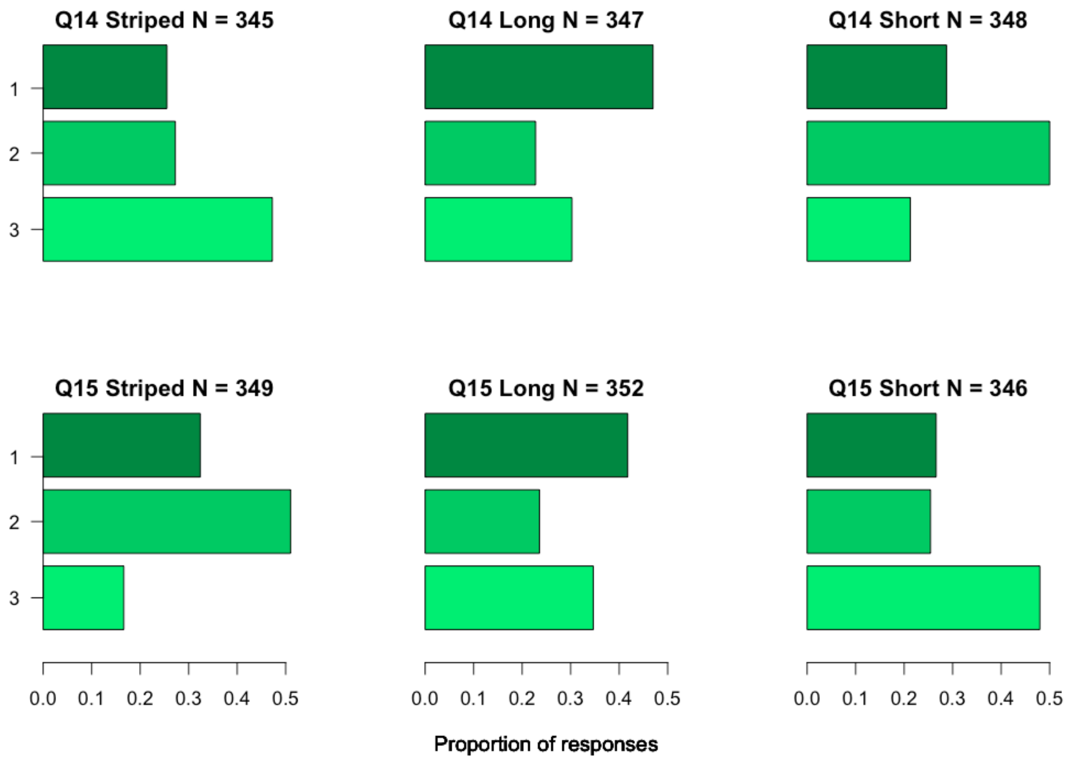


Figure 69: Ranks given by respondents to images of mowing regimes by question. 1 is the most preferred, 3 the least. Each row of this graph represents one question in the survey, where three images of different mowing where ranked against one another. Each small graph represents one image.

5.5.6 Analysis of free text responses relating to 'likes' and 'dislikes' in the images of floral display

5.5.6.1 What reasons did people give for their preferences?

To investigate what motivated people's preferences in the photo-based questions further, they were asked to briefly explain their likes and dislikes in free text boxes in the survey. The questions were phrased: "Please briefly explain what you liked in the pictures in the survey so far" and "Please briefly explain what you disliked in the pictures in the survey so far". These results were visualised by co-occurrence of words to show the key themes. To examine these in greater detail key words and phrases were obtained using Rapid Automated Keyword Extraction.

5.5.6.2 Word co-occurrence

Plots of word co-occurrence were created to draw out some of the key themes in people's preferences in the answers to the free text questions on 'likes' and 'dislikes'.

For the free text question regarding people's 'likes' in the floral display images (Figure 70) the words which occurred together most frequently were 'flower' and 'wild'. 'Colour', 'colourful', 'grass' and 'bed' also occurred frequently with the word 'flower'. 'Natural' was also a key word, occurring with words such as 'display' and 'planting'. This suggests that colour and naturalness were key themes in respondents' 'likes' in the images. 'Grass' co-occurred with 'short' and 'long'. Some respondents had a preference for each type of mowing.

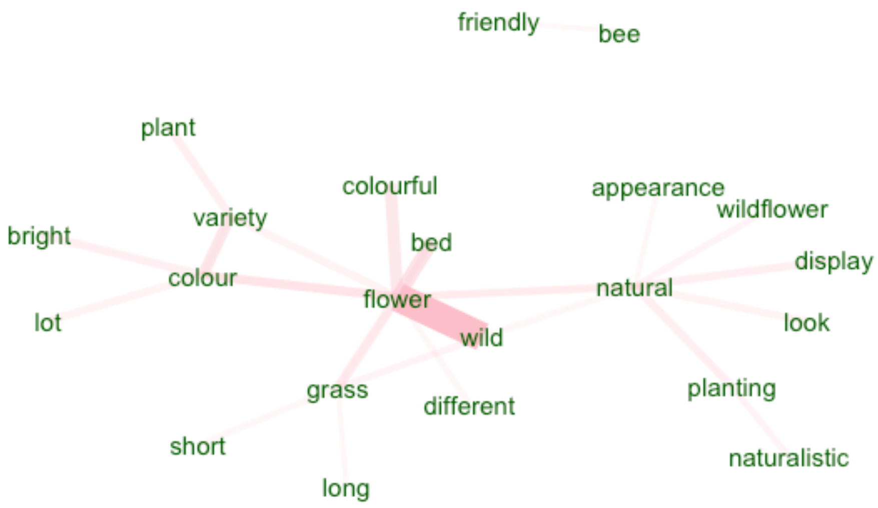


Figure 70: Word co-occurrences within 3 words for the answer to the question "Please briefly explain what you liked in the pictures in the survey so far" with reference to floral bedding and grass mowing.

'Flower' and 'bed' were the most commonly co-occurring words in the question 'dislikes' free text question (Figure 71), some of the other words occurring with these two included 'formal' and 'same', suggesting that people disliked formal beds. Another key group of co-occurring words centred around 'soil', 'bare' and 'earth', also with 'lot' and 'much' suggesting an excess of these; this demonstrates that planting with gaps was a key dislike. As in the 'liked' responses, 'grass' co-occurred with 'short', 'long', 'mown' and 'cut', This suggests that some respondents dislike long grass and some dislike short grass. However, the sentiment intended by the respondent may not always match the sentiment of the question ('like' or 'dislike'). For example, the respondent might say "I like short grass more than long" and both 'short' and 'long' could be identified as keywords for the 'like' question. This is investigated further in Section 5.5.6.3 below.

Figure 71: Word co-occurrences within 3 words for "Please briefly explain what you disliked in the pictures in the survey so far" of floral bedding and grass mowing.

5.5.6.3 Rapid Automated Keyword Extraction of Likes and Dislikes in the Flower Bed Images

In order to understand the reasons for respondents' likes and dislikes in the images of floral displays, a Rapid Automated Keyword Extraction (RAKE) was applied to responses to the question "Please briefly explain what you liked in the pictures in the survey so far" (Figure 72). The resulting keywords related to natural planting, wild flowers and colour. Formal and neat also appear in the 'likes', suggesting some prefer formal styles.

RAKE of "Please briefly explain what you disliked in the pictures in the survey so far" (Figure 73) showed that bare soil was disliked. Long grass and mown grass were both identified by RAKE with very similar scores, so again it seems people's preferences for grass length varied. People disliked "formal bedding". "Boring" and "bland" were also mentioned.

“Formal” appears in responses to both questions suggesting that it is liked by some and disliked by others. It is one place higher in the hierarchy on the ‘like’ graph than the ‘dislike’ graph and received a higher RAKE score.

In the majority of cases, in the manual analysis, the respondent’s intended sentiment for the identified keywords matched the positive sentiment of the ‘like’ question (see Table 12). For example, 7 people mention ‘bright colours’ because they liked bright colours in the images. Conversely, in the case of the keyword ‘formal’ the respondents were indicating that they preferred natural to formal planting, they actually disliked formal planting, so their sentiment did not match the negative sentiment of the question. In some cases, the sentiment was neutral, for example for the key word of ‘neat’, one of the respondents preferred “neat but not too neat”. There were some keywords where the sentiment of the respondent matched the question in the majority of cases but occasionally differed, see Table 12. Nine of the respondents mentioning ‘bed’ were stating that they preferred natural planting or that there was a place for both natural and formal planting.

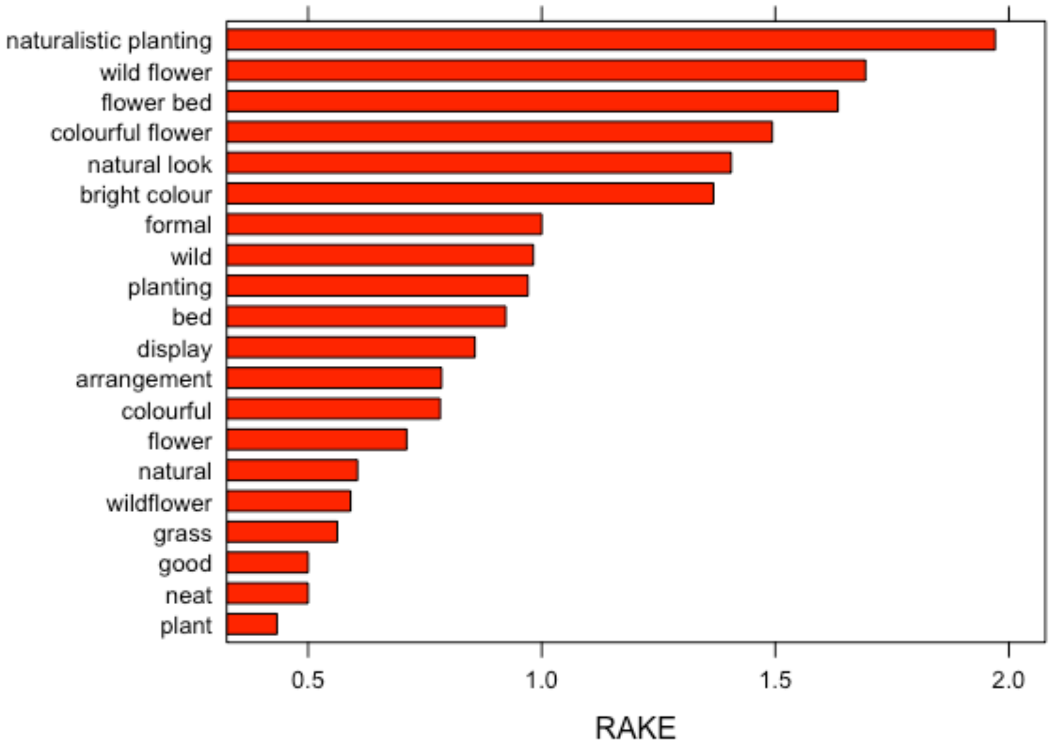


Figure 72: Rapid Automatic Keyword Extraction of responses to "Please briefly explain what you liked in the pictures in the survey so far" of floral bedding and grass mowing.

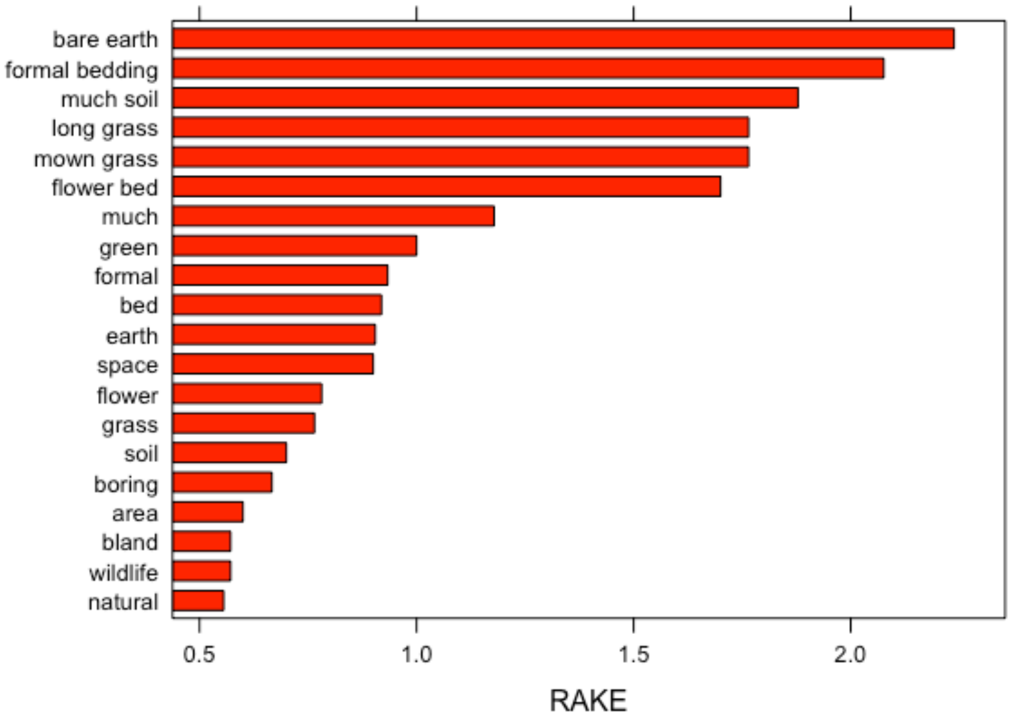


Figure 73: Rapid Automatic Keyword Extraction of responses to "Please briefly explain what you disliked in the pictures in the survey so far" of floral bedding and grass mowing.

Table 12: A manual examination of the keywords obtained through Rapid Automated Keyword Extraction for the question "Please briefly explain what you liked in the pictures in the survey so far" (of park features). +ve in the table denotes is positive sentiment and -ve is negative sentiment, neutral means that the respondent did not indicate a positive or negative sentiment for the keyword.

Keyword	+ve	-ve	Neutral	Comments/themes
naturalistic planting	4	0	1	
wild flower	30	1	0	
flower bed	13	0	0	Some for both formal & natural
colourful flower	9	0	0	
natural look	17	0	0	Most prefer natural, one prefers formal but also likes natural.
bright colour	7	0	0	
formal	0	6	0	
wild	91	1	2	
planting	36	0	0	Mostly related to natural/informal
bed	26	9	0	Some prefer natural, some place for both
display	18	2	1	Most relate to natural, some for both
arrangement	14	0	0	Most relate to natural
colourful	23	0	0	
flower	145	0	0	
natural	87	0	2	Neutral = Need for both
wildflower	23	0	0	Need for both
grass	68	0	0	Natural mentioned, need short for some areas
neat	6.5	2.5	0	4 like = neat grass, 2 like = neat bed, 1 like generally neat, 0.5 = "neat but not too neat"
plant	63	0	0	
TOTAL	680.5	21.5	6	

More subtle opinions were not picked up by the RAKE algorithm, for example where a respondent liked both formal/informal or natural/manmade for example: "there is a place for both. Clacton seafront marvels in its vivid bedding plants. This wouldn't work in a rural park" and "I like flowers to look quite natural as in a wild flower meadow. But I also love formal flower beds too".

Some comments suggest respondents thought that some plantings were really natural e.g. “I liked the pictures in which the plants appeared naturally” and one dislike was “planted flowers”. In fact, all of the photographs were of designed floral displays.

Many mentioned colour and/or a wild appearance, for example “colourful but wild arrangements” and a few mentioned structure “different heights and shapes/textures” and also informality. ‘Wildflower’ (23 mentions) was identified as a keyword as well as ‘wild flower’ (30 mentions), the sentiment was positive in both cases.

In the ‘dislike’ free text question (Table 13) most of the keywords matched the sentiment in the question and indicated something the respondents disliked, apart from ‘wildlife’ and ‘natural’ which were generally mentioned as something that the respondent would have preferred to what was shown in the images. As a dislike, bare ground was mentioned a number of times: ‘bare earth’ (13), ‘earth’ (22), ‘soil’ (33), ‘space’ (10) and ‘much soil’ (6), for example “the beds that had many little flowers but spaced out with too many gaps”. Two opposing qualities of the planting that were referred to, but which produced disagreement, were messiness/informality and neatness/formality which featured in both the ‘like’ and ‘dislike’ sets of answers. Similarly, preferences varied between respondents on long and mown grass with 5 respondents disliking each.

Table 13: A manual examination of the keywords obtained through Rapid Automated Keyword Extraction for the question "Please briefly explain what you disliked in the pictures in the survey so far." (of park features). +ve in the table denotes is positive sentiment and -ve is negative sentiment. , neutral means that the respondent did not indicate a positive or negative sentiment for the keyword.

Keyword	+ve	-ve	Neutral	Comments/themes
bare earth	0	13	0	
formal bedding	0	5	0	
much soil	0	6	0	
long grass	0	5	0	
mown grass	0	5	1	All refer to close mown grass. Neutral = short grass being needed for some uses.
flower bed	0	20	0	Each points out what they don't like: bare earth, regimented, single colour.
much	0	29	4	Relate to *too* much: bare soil, regimented, same flowers. Neutral = e.g. "not much", "I didn't much".
green	0	7	2	negative = beds not in full flower.
formal	0	32	2	
bed	0	60	2	Bare earth, over formal.
earth	0	22		All relate to bare earth
space	0	10	2	Relate to space around bedding plants, too much, too regimented (1 too crowded).
flower	1	58	2	Uniformity, gaps between
grass	0	56	1	A mixture of a dislike of long/unkempt and over-mown/striped. Some mention the need for short grass for some uses.
soil	0	33	0	Bare soil
boring	0	14	0	Boring bedding, uniform, too few varieties.
area	0	5	4	Mostly describe areas not liked by respondent.
bland	0	8	0	
wildlife	6	0	1	Refer to areas being poor for wildlife. Neutral = long grass not for whole greenspace.
natural	15	0	0	Also included unnatural. Referring to preference for natural.
TOTAL	22	388	10	

Overall, the analysis of the free text responses of 'likes' and 'dislikes' in the images showed that informality and floral displays which appear wild were liked. Wilder plantings (wildflower, wild flower, naturalistic planting) were mentioned a total of 57 times as ‘likes’. Wildflower and naturalistic planting received the top two RAKE scores. Formal displays were not explicitly mentioned as a ‘like’, there were just a few cases of respondents mentioning that they like both formal and natural plantings. However, respondents also mentioned “neat” seven times as a positive feature (it received the second lowest score of the keywords extracted by RAKE). Sparse planting and bare soil were key dislikes. Opinions about mowing were more mixed. For example, ‘long grass’ and ‘short grass’ were mentioned specifically as a ‘dislike’ by 5 respondents each. There were 68 mentions of grass in the ‘likes’ and 56 mentions in the ‘dislikes’, these spanned a varied range of opinions. For example, “semi-mown grass” was how one respondent described what they liked, another stated that “amenity mown grassland is bland and uninspiring”, another felt that long grass might lead to problems with litter. Twelve respondents expressed the need for compromise with grass length, for example one wanted grass “not too finely mown but not too bumpy to walk on” and another liked “rough grass though some still mown for children to play”.

5.5.7 Image colour analysis

5.5.7.1 Was colour a key reason for preference in the images?

‘Colour’/‘colourful’/‘color’ and ‘colorful’ were mentioned in the ‘likes’ or ‘dislikes’ of 132 respondents in total. Further investigation of colours in the images was warranted as the number of responses relating to colour suggests colour may be a key factor in determining people’s preferences.

Colour distance plots were created in order to investigate whether the variation in colour in the images was a key factor in people’s preferences and whether images of a particular colour combination were favoured. Figure 74 to Figure 77 show the difference in colours as measured by earth mover’s distance. The colours were extracted as binned histograms, from all of the images of floral bedding. The binned colour histograms which these plots were based upon are included in Appendix 3.3.

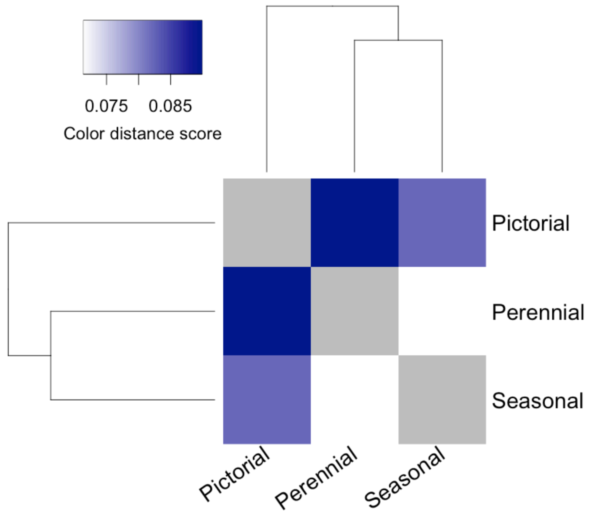


Figure 74: Colordistance plot of photographs of perennial beds, seasonal beds and Pictorial Meadows. Lightest colour denotes that the colours in the group of images were most similar (least distance between the colours in the images). Darker colours indicate that the colours in the images in the groups were more different.

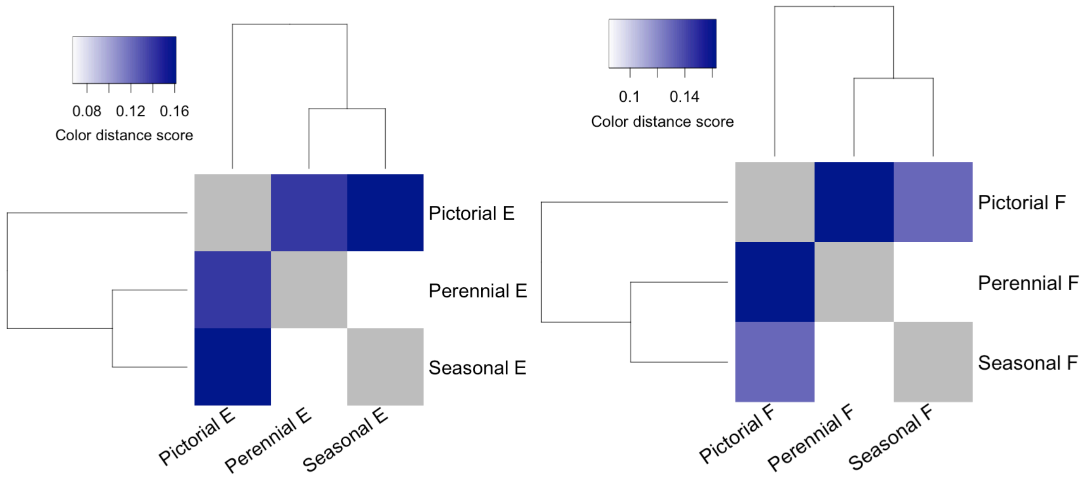


Figure 75: Colourdistance plots of photographs of perennial beds, seasonal beds and Pictorial Meadows, early in the season (left) and when plants were in full bloom (right). Lightest colour denotes that the colours in the group of images were most similar (least distance between the colours in the images), darker colour indicates that the colours in the images in the groups were less similar. Note that the scale varies between the 3 plots.

Perennial and seasonal bedding had the greatest similarity in colours within them, when all of the images were grouped together (Figure 75), as well as when the images were treated separately for early (Figure 75, left) and full bloom (Figure 75, right) displays. When the plants in the images were in full bloom, the perennial bedding group and Pictorial Meadows group were the least similar to one another in terms of colour. In the photographs taken early in the season, seasonal bedding and Pictorial Meadows were the least similar.

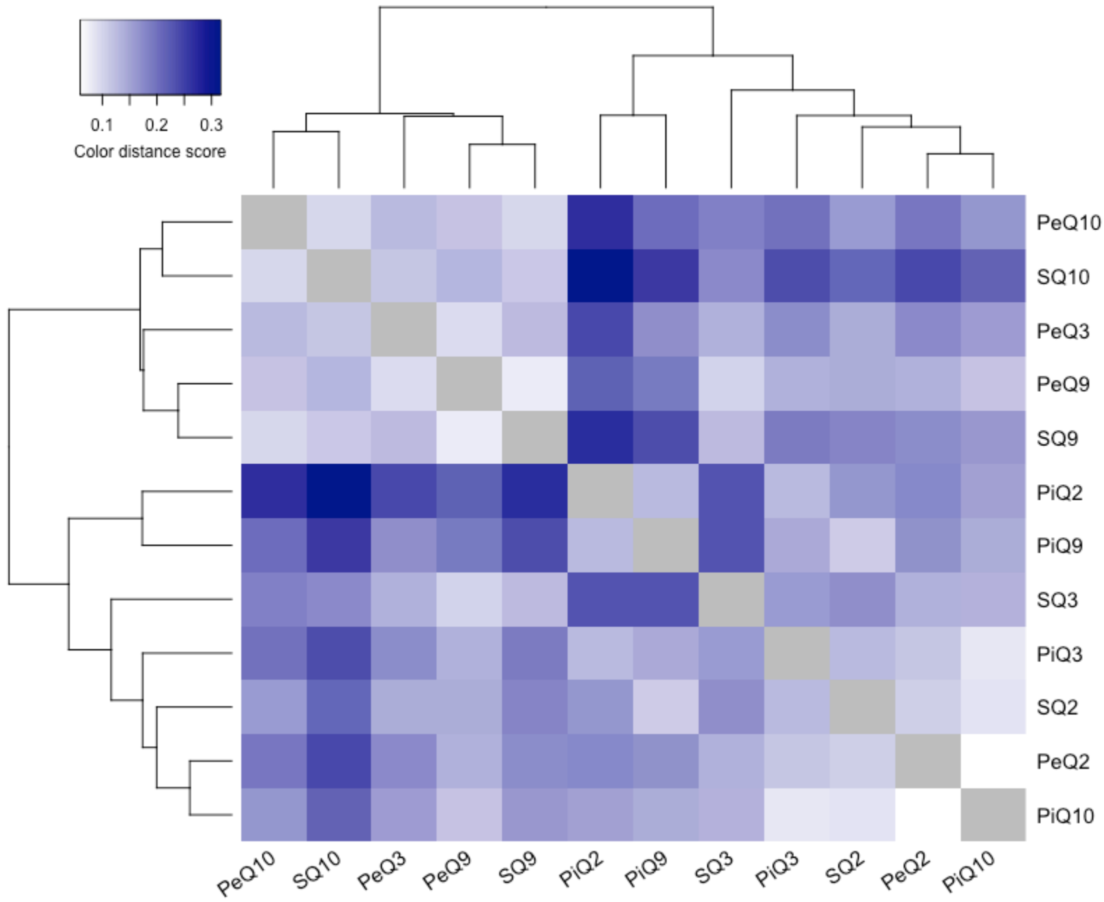


Figure 76: Colour distance plots of "early" bedding images which were not yet in full bloom (S = Seasonal bedding, Pe = Perennial bedding, Pi = Pictorial Meadows, Q and number denotes question number in the survey). Lightest colour denotes most similar colours between the two images.

Figure 76 does not show a clear pattern in the similarity of the photographs taken early in the season, for each type of bedding. For example, all images of perennial bedding might be expected to form clusters; however, they do not. Some images were dissimilar to other images of the same type of bedding, for example seasonal bed Question 3 and seasonal bed Question 10; some images of different categories were similar, for example perennial bed Question 2 and Pictorial Meadow Question 10. The cluster in the top left of Figure 76 shows that three of the four images of perennial bedding were quite similar to one another and to two of the four images of seasonal bedding.

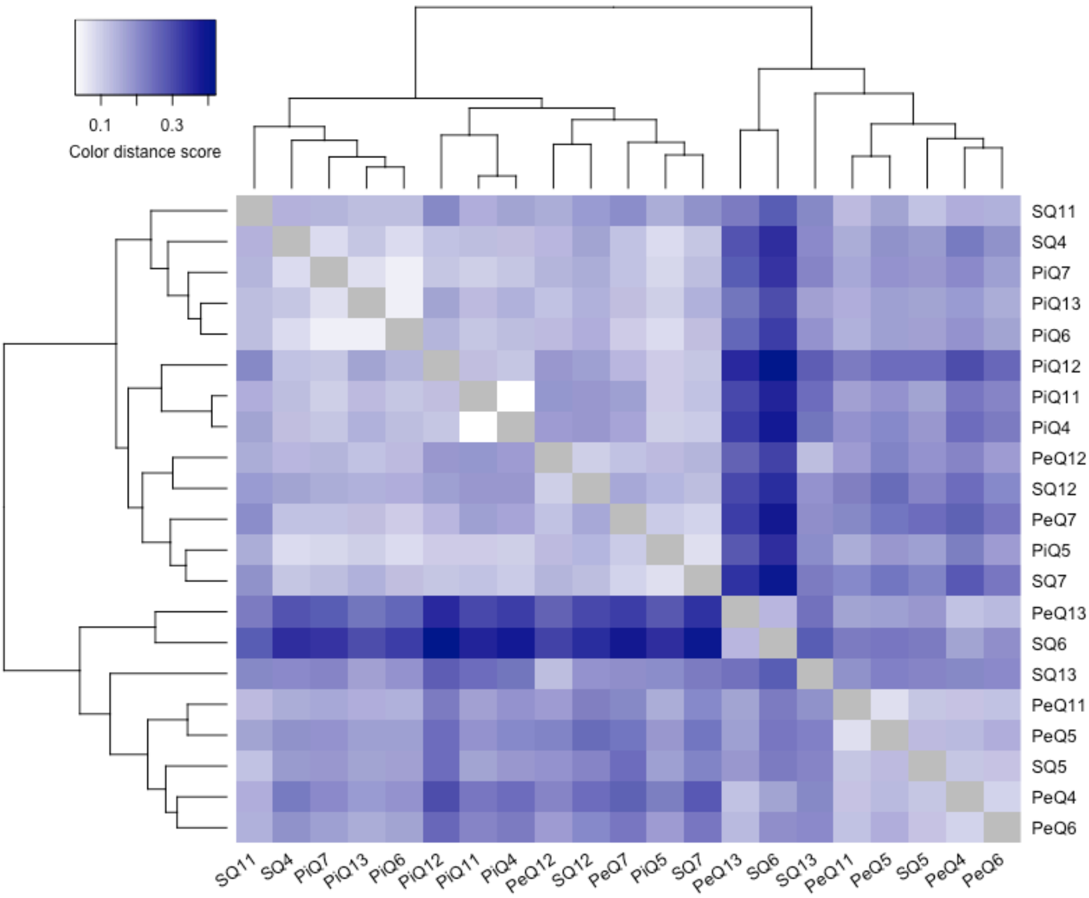


Figure 77: Colour distance plots of bedding images in full bloom (S = Seasonal bedding, Pe = Perennial bedding, Pi = Pictorial Meadows, Q and number denotes question number). Lightest colour denotes most similar colours between two images.

Images of the same type of bedding might be expected to contain similar colours. For the images of plantings in full bloom, Figure 77 shows that some of the images contained similar colours to other images of the same type of bedding. For example, the Pictorial Meadow image in Question 4 and Pictorial Meadow image in Question Q11 contained similar colours as did seasonal bed image in Question 4 and seasonal bed image in Question 6. However, there were also images belonging to the same group that were contained very different ranges of colours. For example, the images of a seasonal bed

Question 7 and a seasonal bed Question 11. As for the “early” images where plants are not in full bloom (Figure 76) the same type of bedding does not form a cluster in the graph which indicates variation within each type of bedding as well as within each.

Colour distance plots (Figure 74 to Figure 77) showed that many images were dissimilar a large number of the other images, in particular the images of perennial bedding in Question 6 and seasonal bedding Question 13. The images from Question 6 and 13 did not stand out in terms of the scores they were given by respondents, so the fact that they differ from a lot of other images may not relate to their preference scores. Images from the same bedding type were different in colour from one another in the majority of cases; it does not seem that there is a particular set of colours dominating any of the bedding types.

Images with a large amount of brown hues (see Appendix 3.3) tended to receive lower Likert scores than those without a lot of brown. The images with a lot of brown were generally of seasonal bedding which was sparsely planted and revealing large areas of soil in the image. Many of the ‘early’ images where the beds were not yet in full bloom were predominantly green, these also had low scores. The perennial bed in Question 3, was also not yet in full bloom, and had soil showing, but it had the second highest scoring of the ‘early’ group, perhaps because the different coloured vegetation provided more colour and interest. The seasonal bedding in full bloom had a range of colour, other than green, but still scored lower than the other types, suggesting that colour is not the only feature of interest.

In the ranked images of floral bedding not yet in full bloom (Appendix 3.3) perennial bedding had the highest mean rank. Again, this was probably due to the colourful vegetation, Pictorial Meadows came second, these images were predominantly green. Again, the images of newly planted seasonal bedding had a lot of bare earth showing and ranked lowest of the floral displays. In the ranked images of beds in full bloom the Pictorial Meadows ranked highest, perennial bedding second and seasonal bedding last, even though seasonal bedding contained a lot of colour, again suggesting that colour is not the only factor affecting preference.

5.5.8 Characteristics of respondents for the complete questionnaires

Demographic information about the 244 respondents who answered all of the questions is shown in Figure 78. The full dataset, including the surveys with missing values (N=407) was not included in the graphs or analysis based on the demographic questions, as many of these questions, being close to the end of the survey, were missed by the respondents who did not complete all of the questions. Most of the respondents were regular park users, therefore they were likely to have an opinion on their likes and dislikes in greenspace. Most respondents, 84%, visited a park once a week or more, and 7% visited less than once a month. In the survey carried out for the *Monitor of Engagement with the Natural Environment MENE* (Natural England, 2018) 65% of adult respondents visit the “natural environment” at least once a week and 16% visit once a month or less or never. MENE is part of Kantar, an ongoing, government funded, face to face survey, collecting 800 responses per week. The current study’s sample visits greenspace more often than MENE respondents visit the natural environment, this might be expected as they self-selected for a survey relating to greenspace. The effect of visit frequency is investigated to allow for this.

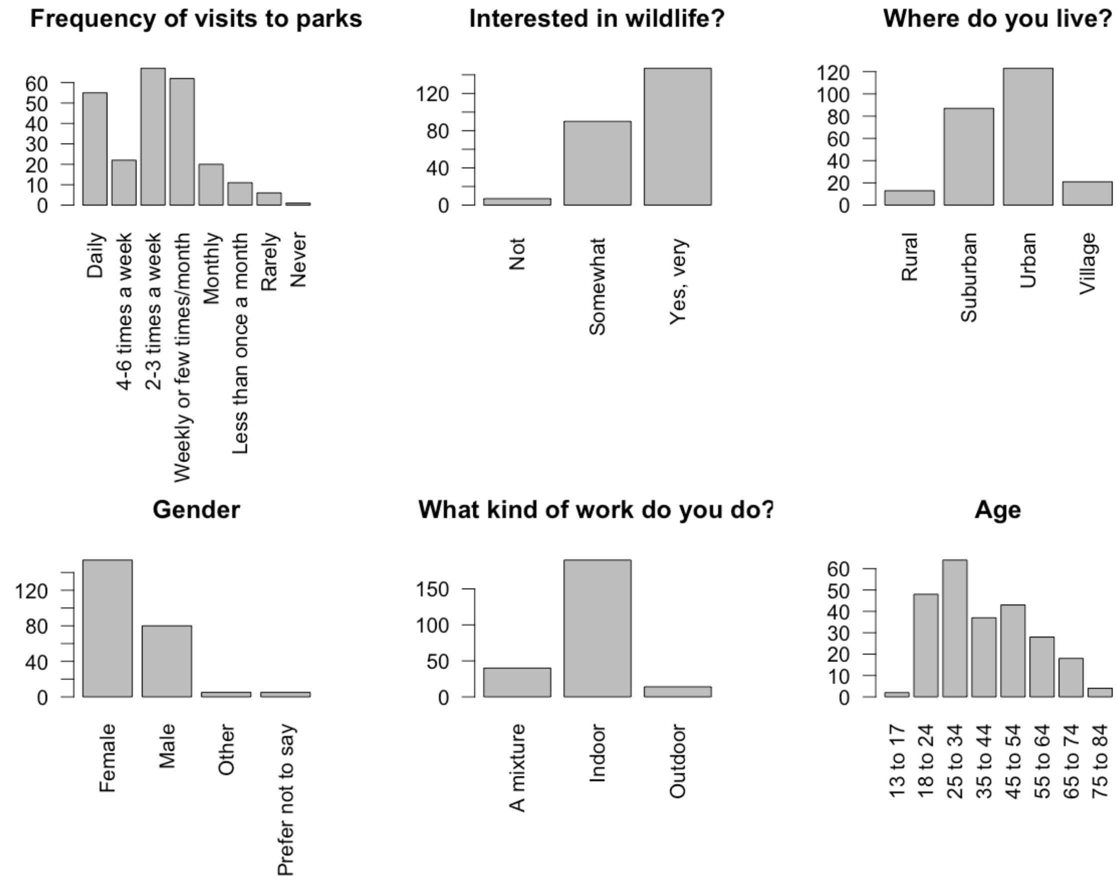


Figure 78: Characteristics of respondents of the 244 complete survey responses.

The locations of the respondents in the full dataset are shown in Figure 79. From a visual inspection of the map, these appear to have been spread across most of the major urban centres in England. There were fewer responses from rural areas, where the population is less dense. The majority of respondents, 86%, defined where they live as urban or suburban. As 83% of the UK's population is urban (World Bank, 2018), this sample is approximately representative of the UK population. There were also few responses from Scotland and Wales. Of the 244 complete responses, 52 were from respondents living outside of the UK. The locations of these respondents are shown in Table 14.

Figure 79: Location of UK survey respondents in the complete dataset. N=192. Map created in: https://www.doogal.co.uk/BatchGeocoding.php

Table 14: Location of non-UK survey respondents

Country	**Respondents**
USA	16
Canada	13
Netherlands	5
Germany	3
Ireland	3
Russia	3
Australia	2
France	2
Poland	2
Hungary	1
Japan	1
Korea	1

The majority, 97%, of respondents were somewhat or very interested in wildlife, as the environment is a topic of great interest this may not be unrepresentative of the general population. In *MENE* (Natural England, 2018) 86% of respondents either agreed or strongly agreed that they were "concerned about damage to the natural environment" and 75% were concerned about the "the consequences of the loss of the variety of life"

In the current study the proportion of female respondents was much higher at 63%, compared to 33% male respondents. The population of the UK is 51% female and 49% male (Office for National Statistics, 2019a). There were only 5 respondents who defined their gender as "other" and 5 who chose "prefer not to say". The effect of gender is investigated in the analysis below (section 5.5.10) to help to allow for the fact that the sample is not representative.

In the question about their work, 77% of respondents had indoor jobs, 5% outdoor and 16% did a mixture of indoor and outdoor work. There was no national statistic to directly compare this with.

Table 15: Percentage of ages of respondents to the greenspace preference survey, and the ages of the UK population according to Office for National Statistics (2019b).

Age	Office for National Statistics	Respondents to survey used in this chapter
0-17	21.3	0.8
18-24	9.4	19.7
25-34	13.4	26.2
35-44	14	15.2
45-54	13.7	17.6
55-64	11.7	11.5
65-74	8.7	7.4
75-84	5.6	1.6
85 and over	2.2	0.0

Table 15 gives the age profile of the respondents; this differed from the UK population (Office for National Statistics, 2019b), particularly in the younger age ranges. In the ranges encompassing ages from 35 to 74 the percentages were similar between the survey and the UK population. The effect of age on preference is investigated in the analysis below (section 5.5.11).

5.5.9 Scales with complete survey responses

Figures 80 and 81, below, show the preferences of the 244 respondents who completed the survey (with no missing values). The responses to groups of questions (e.g. all perennial bedding) were found to have acceptable internal consistency using 'ScaleReliability' function from the 'UserFriendlyScience' package in R. It was therefore possible to combine responses for each type of bedding into a scale by summing the scores given by each survey respondent for each category of floral display (as described in Section 5.4.3).

5.5.9.1 Scales created from Likert preferences for types of floral display.

For the scales for each floral display category in the Likert based questions, patterns for the perennial bedding and Pictorial Meadows scores were most similar but seasonal bedding tended to score lower than both. Figure 80 shows that distributions were approximately normal (perennial and seasonal bedding were slightly negatively skewed). Normality is an assumption relied upon when using standard linear regressions. This suitability was confirmed by the residual plots performed after the regressions were completed.

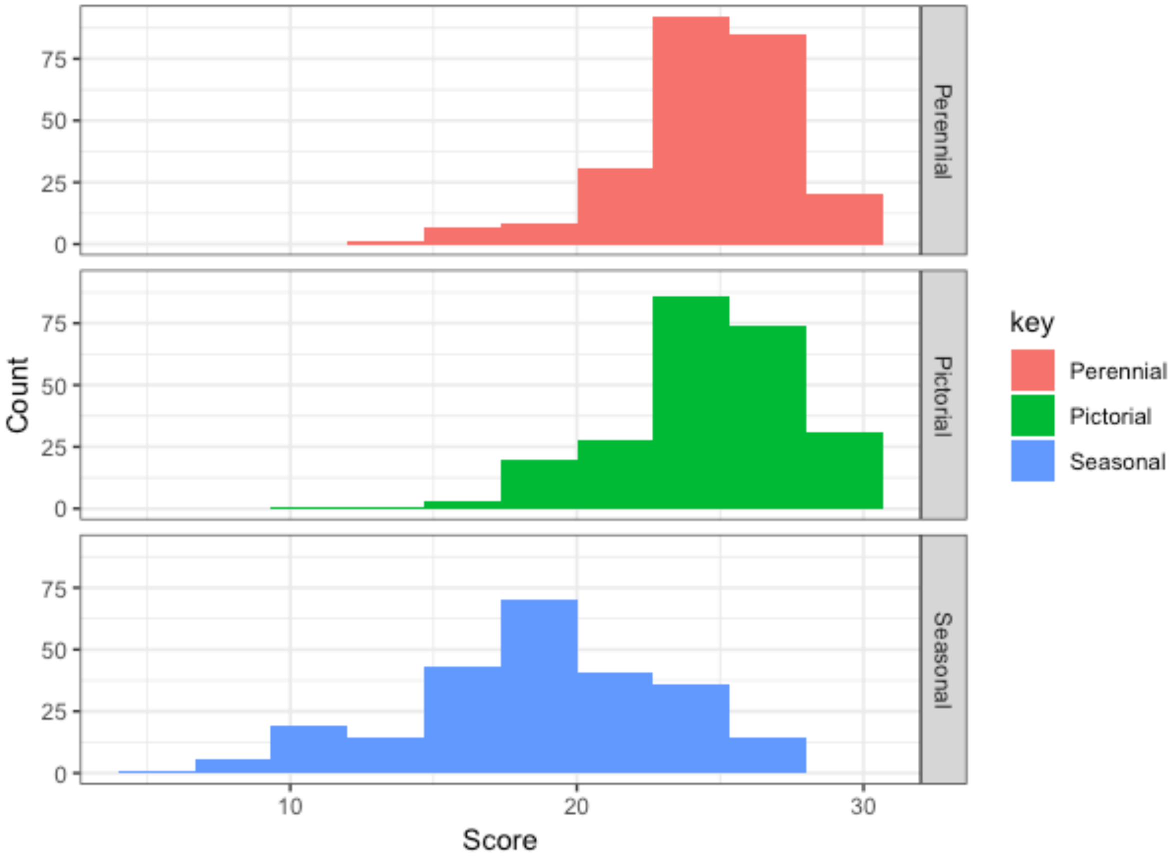


Figure 80: Summed survey responses for each category of floral displays from the Likert style questions (high score = like) n=244.

In a linear regression of the summed Likert scores for images of seasonal bedding against the other two bedding types, scores for perennial bedding had a positive relationship with seasonal bedding (coefficient estimate 0.62, *p*=<0.001). For each increase of 1 unit in Likert preference for perennial bedding, there was an increase of 0.62 in Likert preference for seasonal bedding. Preferences for images of Pictorial Meadows had a negative relationship with preference for seasonal bedding images (coefficient estimate -0.23, *p*=<0.05, for each increase of 1 in Likert preference for Pictorial Meadows there was a decrease of -0.23 in Likert preference for seasonal bedding). This suggest that respondents who liked seasonal bedding also tended to 'like' perennial bedding, but not Pictorial Meadows.

5.5.9.2 Scales created from Rank preferences for types of floral display.

In the rank based questions Pictorial Meadows tended to rank highest and seasonal bedding low. When asked to place the three types of bedding in order of preference, respondents tended to place seasonal bedding last. Regressions were not attempted between the bedding types as rank data are by their nature correlated, which would lead to problems with multi-collinearity as the measures are not independent. Independence is an assumption relied upon when carrying out linear regression (Osborne and Waters, 2002).

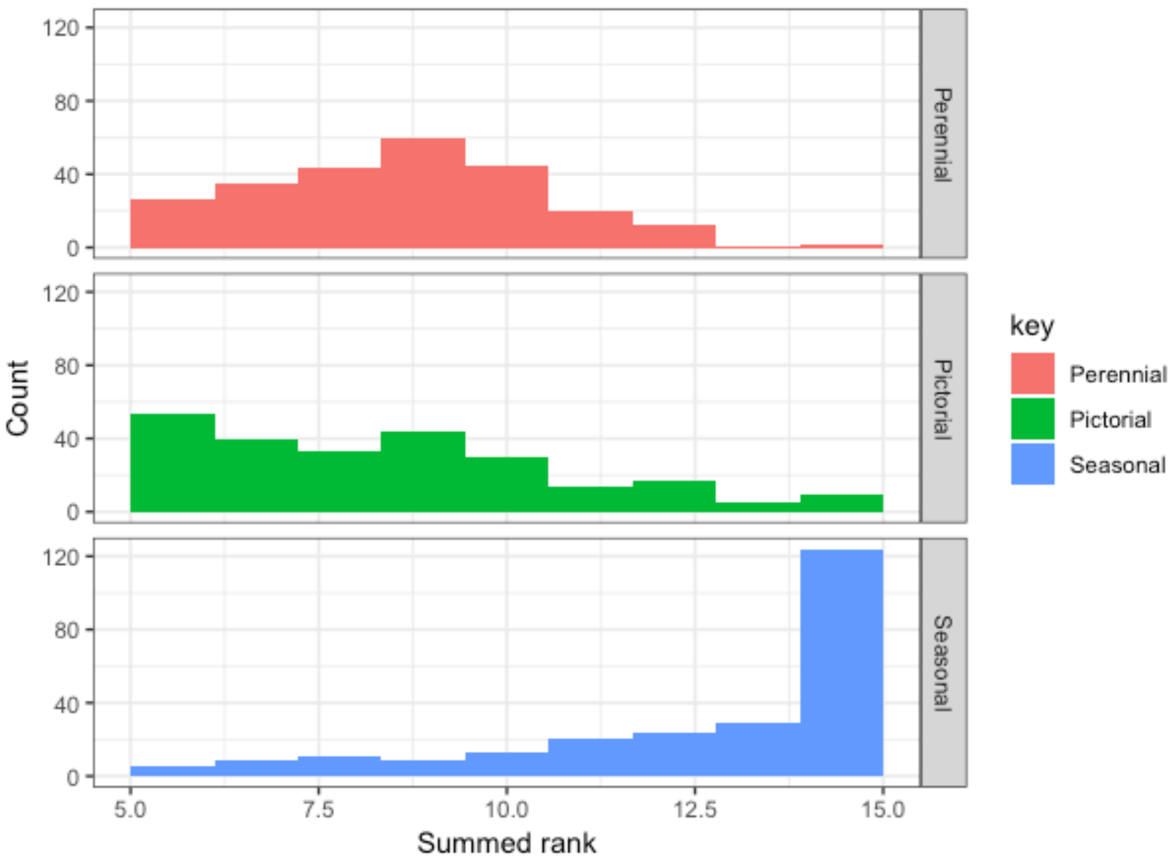


Figure 81: Summed survey responses for each category of floral displays from the rank style questions (low score = like) n=244.

5.5.10 Does Likert floral preference vary with respondents age?

Figure 83 shows the Likert preference of survey respondents for types of floral display. The two highest and two lowest age groups were removed in Figure 83, as there were few responses so they add little to the graph (12 and under: n = 0, 13 to 17: n = 2, 75 to 84: n = 4, 85 and over: n = 0); however, they were included in the regression. The graph (Figure 83), is based on the proportion of respondents due to varying numbers in each age range. It shows only small differences between the age groups in terms of their preferences.

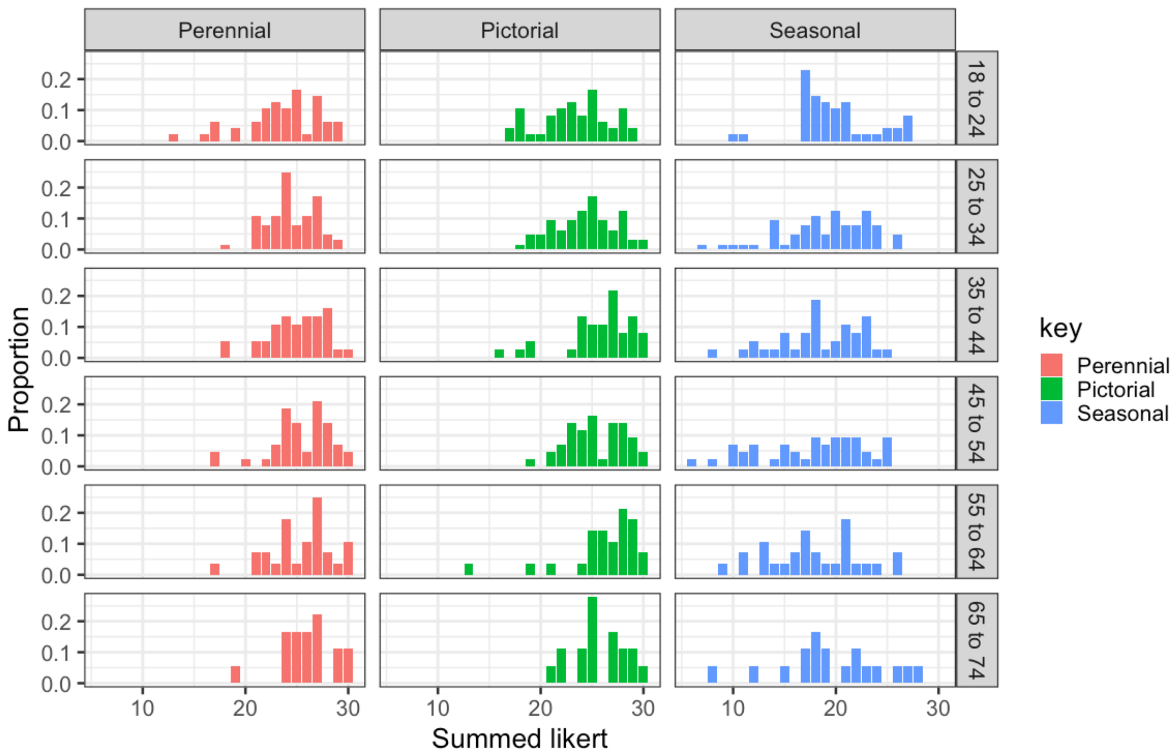


Figure 83: Summed Likert based question survey responses for photos of each type of floral display, by age group (RHS), shown by proportion of age group. Using the 244 responses with no missing values.

A linear regression was built with the Likert scale scores of all of the floral types and age, with seasonal bedding as the dependent variable, and the age groups were treated as categorical or dummy variables. Treating a categorical variable as a dummy variable means each category becomes a separate binary variable in the regression, in this case each age group is a variable, coded 1 or 0 to denote whether the observation belongs to that category or not. None of the age groups had a statistically significant effect how respondents ranked floral bedding.

When age of the respondent was included as a numeric variable, using the mid-point of each of the age ranges, in a linear regression of all of the floral types, with seasonal bedding as the dependent variable, there was a small negative effect of age (coefficient estimate -0.046, p= <0.01, for each increase of 1 in age there was an decrease of 0.046 in Likert preference for seasonal bedding).

Individual regressions of each type of bedding against respondent age as a numeric variable, using the mid-point of each of the age ranges, seasonal bedding did not have a statistically significant relationship with age of respondent. Increasing age of respondent had a small positive effect on their preference for perennial bedding (coefficient estimate 0.046, p= <0.001, for each increase of a year in age there was an increase of 0.046 in preference for perennial bedding) and age had a small positive effect on respondents' preferences for Pictorial Meadows (coefficient estimate 0.057, p= <0.001, for each increase of a year in age there was an increase of 0.057 in the preference score for Pictorial Meadows). The Likert preference score for images of perennial bedding and Pictorial Meadows increased slightly with respondent's age, as seen in Figure 83.

5.5.11 Does Likert floral preference vary with gender of the respondent?

Figure 84, shows the respondents' Likert preferences for floral displays separated by gender of respondent. "Other" and "prefer not to say" genders were removed as there were only 5 respondents in each category, they were included in the regression. Figure 84, with the proportion of respondents, show no pronounced difference in preferences for floral display by gender.

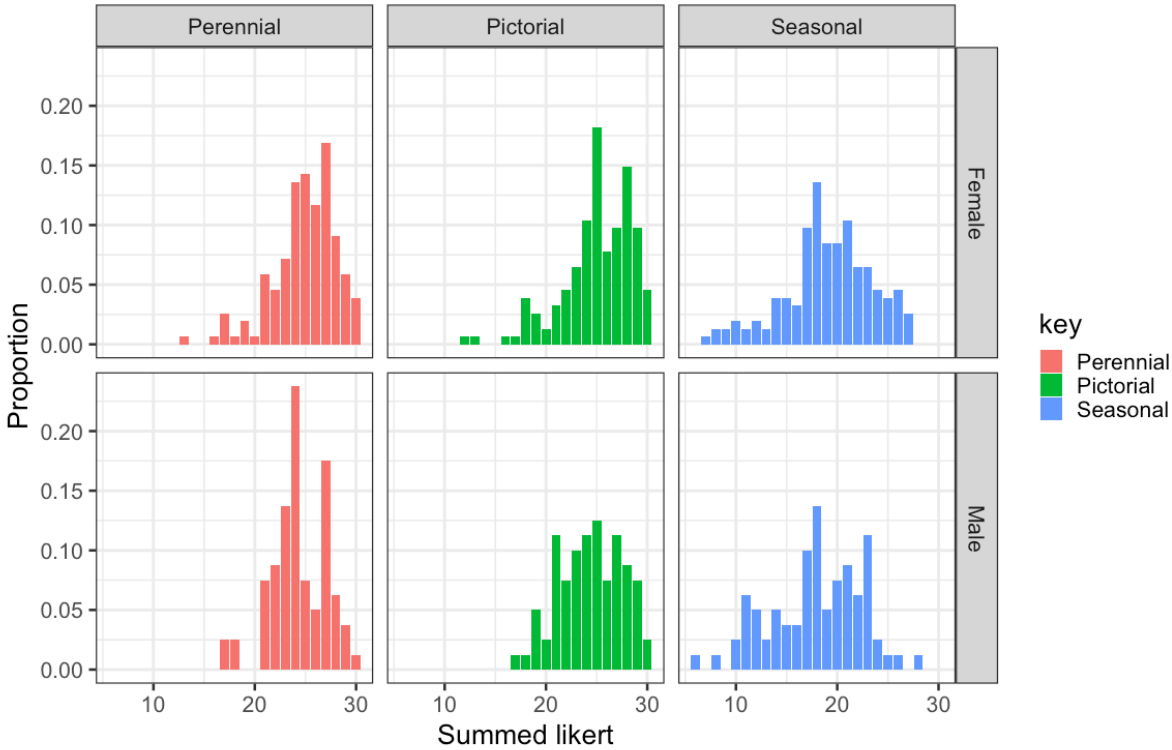


Figure 84: Summed Likert based question survey response score for types flower bed images, by gender (RHS), shown by proportion of gender. Using the 244 responses with no missing values.

In a linear regression of all of the floral types and gender treated as a categorical variable, with seasonal bedding as the dependent variable, none of the gender groups had a statistically significant effect on preference for photographs of floral display.

5.5.12 Other characteristics of the respondent, relationship with Likert score.

No significant relationships were found between where respondents lived (urban, suburban, rural, village) and preference for each of the floral display types. Indoor and outdoor jobs did not have a significant relationship with floral preference.

Respondents who were “very interested” in wildlife had significant positive relationships with their preference for perennial bedding (coefficient estimate 2.68, p =< 0.05, for each increase of 1 in their interest in wildlife there was an increase of 2.68 in their preference for perennial bedding) and Pictorial Meadows (coefficient estimate 3.83, p =< 0.01, for each increase of 1 in their interest in wildlife there was an increase of 3.83 in their preference for Pictorial Meadows). None of the other relationships between interest in wildlife and floral preference were significant.

There was no significant relationship between the frequency at which respondents visit parks and their preference for seasonal or perennial bedding. Frequency of park visitation had a small positive relationship with respondents’ preference for images of Pictorial Meadows (coefficient estimate 0.41, p =< 0.05, for each increase of 1 in the scale of frequency of park visitation there was an increase of 0.41 in preference for Pictorial Meadows) suggesting that people who visit parks often like Pictorial Meadows more than those who do not.

A linear regression of floral preference and the scale created from questions on people’s preferences on wildlife in greenspace and formal vs informal management was carried out. A higher number on this scale suggests the respondent is more accepting of informal management and nature in greenspace. A preference for seasonal bedding had a small negative relationship with the scale (coefficient estimate -0.36, p =< 0.001, for each increase of 1 in their preference scale there was a decrease of 0.31 in preference for seasonal bedding). A preference of perennial bedding had a small positive relationship with the scale (coefficient estimate 0.12, p =< 0.05, for each increase of 1 in their preference scale there was an increase of 0.12 in preference for perennial bedding) as did a preference for Pictorial Meadows (coefficient estimate 0.38, p =< 0.05, for each increase of 1 in their preference scale, there was an increase of 0.31 in preference for Pictorial Meadows)

5.5.13 Does how respondents rank the floral displays vary with age?

Figure 85 shows how the survey respondents ranked the type of floral display in relation to their age group. The two highest and two lowest age groups were removed for Figure 85, as there were few responses (12 and under: n = 0, 13 to 17: n = 2, 75 to 84: n = 4, 85 and over: n = 0). In the graph, which shows the proportion of respondents of each age and the summed rank for each bedding type, people in the middle age groups tended to rank their preference for seasonal bedding lower than younger and older age groups.

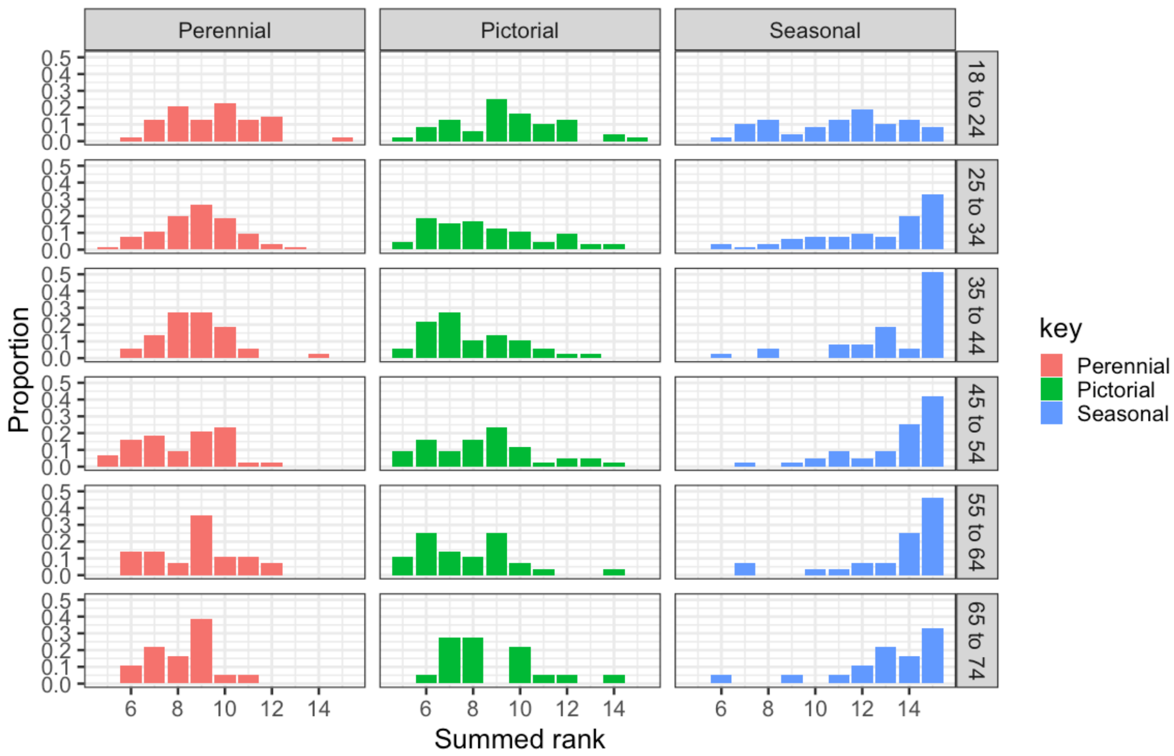


Figure 85: Summed rank based question survey responses to flower bed images, by age group (RHS). Shown by proportion of age group. Using the 244 responses with no missing values.

Regressions of the ranks of preferences for bedding types against one another were not carried out due to multicollinearity which violates the assumption of independence between variables, therefore affecting the accuracy of the model. Linear regressions of preference for each bedding type against age as a categorical (dummy) variable did not show statistical significance. When age is treated as a numerical variable, using the mid-point of each age range, increasing age had a small negative correlation with perennial bedding rank survey responses (coefficient estimate -0.023, p=<0.001, for each increase of 1 in age there was an decrease of 0.023 in their in rank for perennial bedding), as did age with Pictorial Meadows (coefficient estimate -0.019, p=<0.05, for each increase of 1 in age there was an decrease of 0.019 in their rank for Pictorial Meadows), seasonal bedding rank had a small positive correlation with age (coefficient estimate 0.042, p=<0.001, for each increase of 1 in age there was an increase of 0.042 in their rank for seasonal bedding). With increasing age people ranked seasonal bedding slightly worse (a higher rank number is a lower preference) and perennial bedding and Pictorial Meadows slightly better. These models suggest that as people get older their preference for perennial bedding and Pictorial Meadows increases, while their preference for seasonal bedding decreases. These effects are statistically significant but small.

5.5.14 Does how respondents rank the floral displays vary with gender?

Figure 86 shows how respondents ranked the images of types of flower by their gender. “Other” (n=5) and “prefer not to say” (n=5) genders were removed as there were few responses so they add little to the graph (Figure 86), but they were included in the regression. The graphs do not show any pronounced difference in ranks in floral preference by male and female genders. Linear regressions of each bedding type against gender as a categorical variable did not show statistical significance.

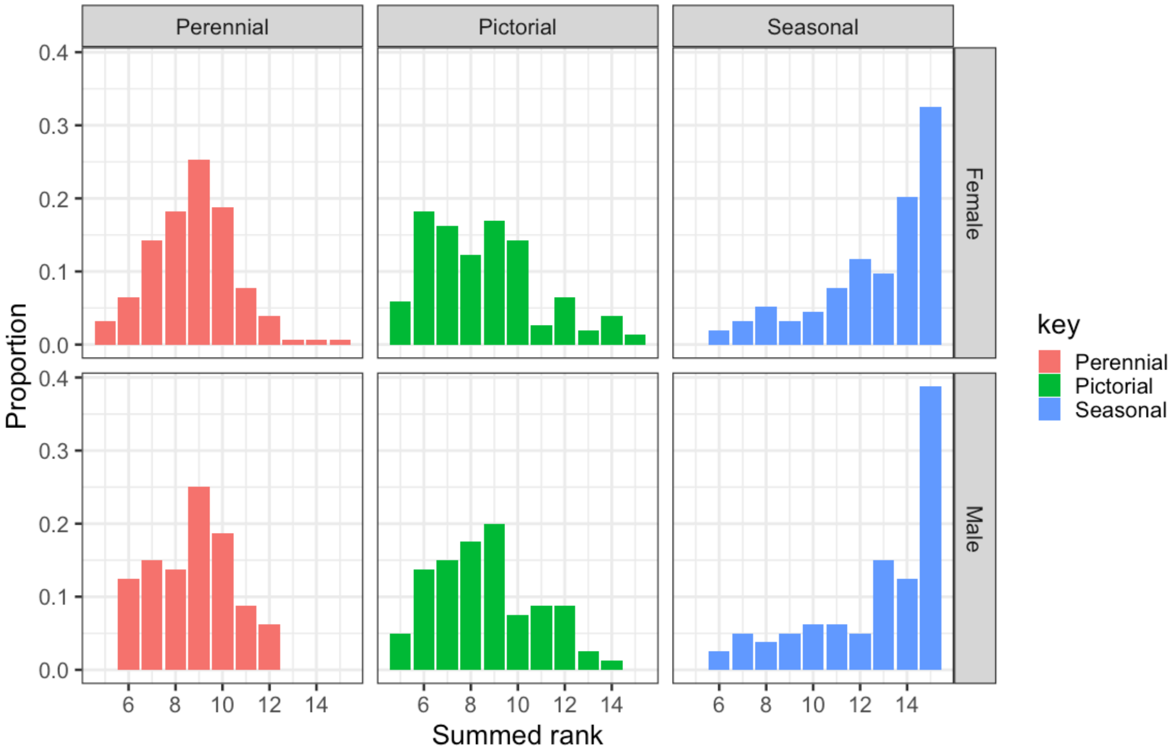


Figure 86: Summed rank based survey question responses to flower bed images, by gender (RHS), shown by proportion of gender. Using the 244 responses with no missing values.

5.6 Discussion

This study investigates people's preferences for types of floral display and mowing regimes in urban parks and greenspaces. This is of particular interest to park managers making decisions on cost effective management of their sites which is still seen as attractive by visitors. It relates to Chapter 3 where the preferences of insect pollinators were explored, and Chapter 4 which investigates people's preferences for different types of landscape at a broader scale.

This study used a survey based on photographs. As outlined in Chapter 4, whilst a photograph is different to visiting a site in person and experiencing it with all of the senses, it can be used as a reliable surrogate (Steen Jacobsen, 2007) and allows collection of a large number of responses over a relatively short timeframe. Further work could include on-site interviews in person.

The initial graphs (Figure 69 to Figure 80) used the whole data set and included the responses which had missing values, which were not included in regressions. In these graphs, Pictorial Meadows were the most preferred type of floral display when all beds were in full bloom, but perennial bedding was preferred early in the season. This may be because perennial beds provide ground cover and colourful foliage throughout the year (as seen in colour plots of images, Appendix 3.3). Hoyle (2015) also found that respondents could enjoy the subtle colours provided by foliage as well as blooms.

When the survey responses for each floral type were summed, to create a Likert scale, using the complete dataset with no missing values (Figure 81 to Figure 88) the regressions showed that images of perennial bedding and Pictorial Meadows received similarly high scores and images of seasonal bedding received much lower scores. Overall, seasonal bedding was the least preferred planting type, though the free text answers allowed respondents to qualify this by indicating that there is a place for both naturalistic and traditional planting. The survey questions asked the respondent to compare one type of bedding with another and this ignores the fact that there may be places for both. For example, a city centre park might be considered a good location for formal features and a greenspace on the rural fringe might not be, or different areas of the same site could benefit from different management approaches.

When the colours were extracted from the images of floral displays, seasonal bedding was shown to be colourful (Appendix 3.3) (and colour was also mentioned as a 'like' by respondents), but this did not translate into high scores, so factors other than colour were clearly important in people's preferences. However, in Hoyle *et al.*'s (2018) study flower colour diversity was shown to have a positive relationship with people's aesthetic response and plant species diversity was not.

Some images of the same type of bedding were shown to be dissimilar in the colour distance plots (Figure 77 to Figure 80), so there was no key set of colours in a type of bedding that was driving preference. When the images were grouped by floral display type and colour distance plots created of the colour differences between these groups, seasonal and perennial bedding were the most similar to one another, this suggests that replacing seasonal bedding with perennial bedding could have the least impact, for those who do enjoy seasonal bedding. Preference for perennial bedding had a positive relationship with preference for seasonal bedding. In contrast, preference for Pictorial Meadows had a negative relationship with preference for seasonal bedding. This suggests that perennial bedding would be a more acceptable replacement for seasonal bedding. Pictorial Meadows are different in form, planted in broad swathes, so it could be suggested that they should be an addition to the other forms of bedding, not a replacement for them.

According to Berlin and Kay (1969) there are eleven basic colour names which they claim are universal between languages (though some languages may not use all eleven colours); this has been supported by others (e.g. Sturges and

Whitfield, 1997). Many factors can affect the perception of colour including the device on which the image is viewed and the linguistic and cultural background of the viewer, but perception of colours is also individual, even speakers of the same language may not agree on the boundaries of a colour (Dedrick, 1998).

It was fairly straightforward here to assign a numeric colour code to each pixel in a flower bed image, or to each bin or K-means cluster extracted from an image (in Appendix 3.3) or to the individual pixels in the image. For example, it was possible to assign RGB (red, green, blue) values or HSV (hue, saturation and value) in R (R core team, 2017). It was not so simple to translate this into a named colour, therefore, it is not straightforward to say, for example, that an image was 40% brown or contained 5 colours other than green. This would have assisted in, for example, demonstrating that an image contained a lot of bare earth or that it contained a lot of colourful flowers so that the effect of this on preference could be determined. Colour assignment was trialled initially by matching colours to the nearest RGB values of the default colours in R (R core team, 2017), but it was noted that the assigned colours did not always match the perception of the colour of the author, nor visually match the colour of the R default colour.

Munroe (2010) created an online survey to investigate colour names. This survey received 222,500 responses, which Munroe used to assign names to RGB colours. Munroe’s original list of 954 colours created from the survey include colour names such as “baby poop” and “booger”, even after Munroe had removed “spam”. Munroe created a shorter list with 27 colours, which assigns a name to all RGB triplets where one of R, G or B is equal to zero, this gives the RGB values for all the colours which sit on one of the 3 fully saturated faces of the RGB cube. Munroe’s webpage does not describe the process used to map the 954 colours to the 27 colours.

The results of Munroe’s (2010) survey and his 27 fully saturated colours were used by Seresinhe, Preis and Moat (2015) to assign colours to each of the pixels in all of the images in the ScenicOrNot dataset (http://scenicornot.datasciencelab.co.uk) (Data Science Lab, 2017). They map the Munroe's (2010) 27 colours to the 11 basic colours in the English language, for example 'dark green' becomes 'green' (Seresinhe, pers. comm, 2020). There may have been some issues encountered here, for example is 'teal' green or blue? Seresinhe, Preis and Moat matched each pixel in the ScenicOrNot images to the nearest RGB values in Munroe's (2010) data. Many colours will not have had an exact match due to the fact that, in Munroe's 27 colours dataset, one of the RGB values is always zero, how varying this value affects the colour is not taken into account, but the colours were also converted to HSV to allow the authors to add thresholds for black, grey and white. Larger changes in the zero values could change the colour significantly.

Munroe's (2010) results were trialled as a source of colour names in the current study but were discounted due to the issues outlined above. Colour naming is complex and it is not possible to assign a definitive name to a set of RGB values. For this reason, it was decided that it was sufficient for the purposes of this study to state that an image, for example, "contains a lot of brown" based on a visual inspection of the results of pixel binning and k-means clustering (Appendix 3.3). Further study could investigate the accurate assignment of colour names to pixels, but this is complex and beyond the scope of the current study.

Amongst the keywords identified by RAKE in the free text responses to the questions "briefly explain what you disliked/liked in the pictures" there were a range of words relating to form rather than colour, for example "formal" and "bland" appeared frequently in the "dislikes", and "natural" was a keyword in the "likes". This suggests that form is important, as well as colour. An area for further work could be further investigation of factors, other than colour, affecting respondent's preferences for different types of floral bedding, such as the structure (e.g. height and layout) of the beds. It was also noted that, from their comments, some respondents seemed to think that some displays were natural and they preferred these. In fact, all of the images featured flowers that had been planted, and included non-native species. Further work could include investigating people's understanding of greenspace management and how this relates to their preferences. This would allow us to understand how people's knowledge impact upon their preferences. For example, if they understood the ecological value of a habitat would they enjoy it more?

Images of Pictorial Meadows were preferred overall, but if park managers were to replace all floral displays with Pictorial Meadows this would not provide ground cover or floral resources for pollinators and other wildlife early in the season, nor would they provide colour that human visitors enjoy. Southon *et al.* (2017) found that their planted meadows received lower preference scores in winter than in other seasons. The current study did not investigate responses to planting in winter, but this study found a similar trend; images of Pictorial Meadows were less preferred to perennial bedding in the spring, probably because they came into full flower quite late. Photographs taken during the winter were not used in this study, but as Pictorial Meadows are largely based on use of annual seed mixes, photographs taken in the winter would have featured dead vegetation or bare soil prepared for replanting, so these are unlikely to be considered attractive. Images of perennial bedding were preferred early in the season. Perennial bedding provides early colour, including colourful foliage and some blooms, and constant ground coverage. As the images originated from the pollinator study, bedding schemes were only compared in spring and summer. Further work could include all seasons.

Bare soil in floral beds was disliked by respondents, demonstrated by analysis of the free text responses on likes and dislikes in the images, and this was supported by the low preference scores for the images which contained a lot of brown (Appendix 3.3). However, bare earth is important for some pollinators to nest. Bare soil could be provided elsewhere, where it does not affect visitor enjoyment, and where it is not disturbed by replanting operations.

Pollinators preferred perennial bedding to seasonal bedding according to Chapter 3, and this was also true for human respondents in this study, suggesting that replacing seasonal bedding with other types of floral display could be positive for both people and pollinators. Other types of bedding, such as perennial bedding, can also be cheaper to maintain as they do not require regular replanting. Park managers could potentially make budgetary savings, at a time of austerity, while also improving greenspaces for both people and wildlife.

Of the mowing regimes evaluated, long grass was the most preferred. As with the floral displays, some users pointed out in the free text responses, on their likes and dislikes in the images, that there are places for multiple mowing regimes, for example short grass is needed for sports. When the different mowing regimes were ranked in terms of respondents' preference, striped grass was often ranked last. In the Likert question responses striped grass had the most polarised response. As striped grass was disliked and is also costly to maintain, as well as providing little wildlife value, there is little reason to maintain it. Short grass received a lot of second place scores in the rank questions and a lot of 'like a little' responses on the Likert question, probably as people find it unattractive, but recognise that it is useful, for example for sports. Harris *et al.* (2018) found that "lawn" was associated with reduced preference by their respondents, but Özgüner and Kendle's (2006) study included a list of people's preferred features and, in Sheffield's Botanical Gardens, neat lawns featured high on this list. This demonstrates that, in formal areas and for specific uses, short grass is still expected or needed. The range of opinions expressed demonstrates the challenges faced by park managers in implementing management that is acceptable to the widest range of park users possible.

Key themes from the analysis of respondents' stated 'likes' in the images included naturalness, wild flowers and colour. 'Dislikes' included bare soil and formality. This suggests high acceptance for naturalistic planting. For the mowing regimes, the picture was less clear with short and long grass featuring in both ‘likes’ and ‘dislikes’. Gunnarsson *et al.* (2017) also found a correlation between measured biodiversity and human preference suggesting that biodiversity may translate into perceived naturalness, and that people have a preference for natural landscapes.

The effect of gender on floral preference was not statistically significant. The effect of age was small, as was whether the respondent worked indoors or outdoors. There was a positive relationship between frequency of park visits and a preference for Pictorial Meadows, perhaps because those who visit parks frequently were more accustomed to this relatively new planting style. Similarly, Nam and Dempsey (2019) found that people who visit parks more often were more accepting of “meadows with wildflowers”. Preference for the other types of planting did not have a statistically significant relationship with the frequency of visits to parks. Schroeder (1982) found that people who had lived in cities most of their lives preferred “more developed recreation areas” than those who lived in suburban or rural areas for most of their lives. This study compared where respondents currently live to their preference for floral bedding and did not find a significant relationship. Interest in nature had a positive correlation with preference for perennial bedding and for Pictorial Meadows, as did the scale created with people’s attitudes to naturalistic management.

The images of floral display used in the study were all taken in Coventry and were managed by Coventry City Council or the University of Warwick. Management of the same types of bedding may vary in other locations. Further research could include images from a wider geographical area and wider range of land managers. For example, photos could be collected from local authorities around the country who are changing their management and a survey created to compare preferences for these. This could give a wider range of bedding styles for land managers to choose from and would confirm the applicability of the research to a wider geographical area.

The survey attempted to minimise biases by, for example, varying the order of the questions and response choices. However, some biases may remain, such as acquiescence bias when respondents say what they think the survey owner wants to hear or tend to select more positive responses. As this was an open online survey there is a risk of self-selection bias affecting the results, however the demographic information collected about the participants did not show strong correlations with their preferences. Differences in participants' displays, for example size or how colours display, could also exert an effect. Roth (2006) found that in most cases "there is no significant interrelationship between the demographic, motivational, technological or methodological factor and the evaluation results." Roth (2006) found that the differences in how groups perceived landscape were very small and for the most part insignificant and stated that other commentators have overestimated these effects. Where large samples of participants and images are used, he felt that these factors could be largely discounted. Roth (2006) stated "scenic quality assessment is only influenced to a very small degree by demographic and motivational factors". Another online landscape preference study (Wherrett, 2000) also found that "age, gender and nationality did not have any significant effects on the scores given." This agrees with this study, where these effects were also generally found to be small.

In the author's experience, when working in public parks, dense vegetation can sometimes affect perceptions of safety, so careful planning is required to maintain sightlines. For example, there can be complaints about shrub beds close to paths where park users feel someone could be waiting to ambush them. This also seems contrary to Prospect Refuge Theory, the shrubs are seen as harbouring a hazard as opposed to providing refuge. Managing a site for people and wildlife can involve trade-offs, dense vegetation for wildlife should be located and managed in such a way that it does not impact upon park users’ feelings of safety.

5.7 Conclusion

Park managers are making changes in their management under austerity. One such change is the replacement of seasonal bedding with other types of floral display. The current study demonstrated that perennial bedding was preferred over seasonal bedding by respondents to the survey, it was also preferred by pollinators (Chapter 3). Changing to perennial bedding is expected to have positive results for both pollinators and people. As perennial bedding is also generally cheaper to maintain this is positive for park managers who are considering this change. Seasonal bedding also has other environmental impacts, for example it creates waste in the form of plastic pots, greenhouse gas emissions from regular deliveries of new plants and, depending how the plants are grown may include the use of peat and/or chemical fertilisers and pesticides. Due to the fact that perennial bedding is planted once and then maintained, all of these environmental impacts will be smaller. Well planned perennial bedding can provide a floral resource for over a long flowering period, for both pollinators and park users to enjoy. Seasonal bedding is regularly replanted so that it provides flowers throughout the year but this was not reflected in its attractiveness to respondents early in the year in this survey. Pictorial Meadows were also liked by respondents once in full bloom, but they were not attractive early in the season. They are not necessarily a good replacement for other types of flower bed, but they can provide colour and food for pollinators in summer and reduce the area requiring regular mowing.

Another change made by park managers due to austerity is reduced grass mowing. Of the mowing regimes investigated here, striped formal grass was the least favoured, it is also expensive to maintain. Allowing grass to grow long in some areas could be good for wildlife without impacting on human enjoyment, but short grass is required in some areas, for example to allow ball games and picnics.

This study demonstrates that what is good for wildlife and park budgets, in terms of mowing and floral display, can also be good for park users.

6 DISCUSSION

6.1 Introduction

Ongoing UK government ‘austerity’ policies have led to large budget cuts which have forced local authorities to save money. As greenspaces are not a statutory service, they are one of the areas where councils have looked to make budgetary savings. Urban parks and other greenspaces are green areas which are available for public recreation. Urban greenspaces are a key resource for urban populations, as they provide a range of ecosystem services, including supporting biodiversity and providing human enjoyment. Some of the approaches local authorities have tried to reduce costs include reduced frequency of mowing and a move to types of floral display that are cheaper to manage. This thesis investigates the effect of these changes on biodiversity and human preference, using techniques from a broad range of disciplines including life sciences, social sciences, geographical information systems and data science.

So-called austerity measures have had a disproportionate impact upon parks and greenspaces (Heritage Lottery Fund, 2014; APSE, 2016). This thesis sought to identify the impacts of these new approaches on biodiversity, using pollinating insects as indicators, and on human enjoyment, using two different types of survey as well as a study using crowdsourced data. Another objective (RO5) was to identify any trade-offs between the greenspace management practices which support biodiversity and those that support amenity and, therefore, human enjoyment. The main focus of the study was on the impact of a change in practice from regularly re-planted seasonal bedding to perennial bedding (RO1 and RO2). Other changed practices in the study area included reduced frequency of grass mowing and the use of pictorial meadows. This research is one of the few examples of people’s preferences being compared to those of pollinators in urban greenspace.

One approach to reducing costs is to simply reduce provision. Cameron and Hitchmough (2016) suggest that “rationing” is one response to reduced resources, for example, by reducing the number or size of flower beds. An alternative is to substitute in forms of planting which are less resource and labour intensive. The research presented in this theisis is timely as the findings can be used to help park managers to reduce the impacts of management changes on park users and biodiversity, or potentially improve parks for people and pollinators whilst making budgetary savings.

6.2 Summary

This thesis investigates the management and maintenance of urban parks and greenspaces, and the effects of this on biodiversity and amenity. In particular, this thesis investigated locations where changes are already being made for budgetary reasons, and what impact this is likely to have on both wildlife and human park users. Can changes be managed to benefit both biodiversity and people? This work was undertaken through case studies in the West Midlands, as well as collecting new and existing data at the UK level. Greenspace can contribute to a wide range of ecosystem services. Two key ecosystem services (provided by greenspaces) were focussed upon here, pollination and human enjoyment.

Exploratory Case Studies (Section 2.8) demonstrated that managing greenspaces for wildlife does not necessarily lead to a decline in the quality of horticultural maintenance (which includes features such as flower beds). Changing management practices in greenspaces were identified through literature reviews, and through communication with local authorities in the West Midlands. In the three local authority areas (in which the studies were carried out in Chapter 3) types of floral display were changed and grass mowing frequency was reduced in some areas. In the parks studied, new types of floral display included the replacement of regularly replanted seasonal bedding with perennial bedding, as well as the addition of Pictorial Meadows plantings in some areas. Areas of where the old types of grounds maintenance were ongoing were compared to areas under new management regimes.

The potential impact of these management changes on ecosystem services, in particular pollination, was investigated in the first study by counting pollinators to assess their preference for different types of floral display. This study used pollinating insects as an indicator group and an example of a provider an ecosystem service. The impact of the changes on human greenspace users, in particular visual enjoyment and preferences for different mowing and floral displays, was investigated through two studies (Chapter 4 and 5); firstly, using crowdsourced ratings of scenicness of photographs taken in UK greenspaces, then at a finer scale using a survey with images of the same specific management types used in the pollinator study (Chapter 3).

6.3 Pollinator preferences in greenspace

When pollinators were counted in different types of floral display (Chapter 3), perennial bedding attracted a greater number of species/groups of pollinators and individual pollinators than seasonal bedding. Sampling within quadrats in both types of planting showed that seasonal bedding contained greater floral diversity and a greater number of floral units than those in perennial beds, suggesting that it was not the species richness or quantity of flowers which attracted pollinators.

It is important that a floral resource is available to pollinators in spring and autumn, when flowers are generally scarce, as these are also key periods when insects have recently woken up from, or are preparing for, hibernation (Nowakowski and Pywell, 2016). Late in the flowering season, in the current study, the numbers of flowers in quadrats taken in perennial bedding were lower in some parks than others (Figure 40) and this led to fewer visits by pollinators than seen in seasonal beds (Figure 35 and 36). Flowers that were visited by pollinators late in the season included catmint (*Nepeta sp*.), Verbena (*Verbena bonariensis)*, lavenders (*Lavandula* spp.) and ice plant (*Hylotelephium spectabile*). These plants could be considered by park managers when planning perennial beds to ensure a floral resource in late summer. Overall, the findings described in Chapter 3 suggest that perennial bedding can be better for pollinators than seasonal bedding, especially if a range of species are chosen to provide a continuous floral resource.

Previous studies have investigated the attractiveness of particular plants to pollinators (Corbet *et al.*, 2001; Garbuzov and Ratnieks, 2014b, 2015; Salisbury *et al.*, 2017; Rollings and Goulson, 2019) and their findings could be used to inform park managers about planting choices, for example by creating lists of plants which are useful to pollinators and advising on mixes of species which would collectively provide a long flowering period. However, some lists of 'pollinator friendly' plants should be used with caution. Garbuzov and Ratnieks (2014a) found that the authors of most of the plant lists that they assessed did not state how the inventories were formulated and that most were probably based on authors' general knowledge as opposed to empirical study. A large number of plants which are attractive to pollinators were not included in the lists, for example borage and open-flowered types of dahlia, which the authors had shown in a previous study to be well used by pollinators (Garbuzov and Ratnieks, 2014b). Plants which were not attractive to pollinators, such as certain hybrids, were often included in the lists. Many of the lists lacked detail, for example they named a genus as opposed to a species, and not all members of the genus would be equally attractive to pollinators. In addition, they did not comment on the relative attractiveness of different plants to pollinators.

The preferences of pollinators for different grass mowing regimes in parks are more challenging to assess. For example, weather conditions and changes in the availability of maintenance staff mean that the cycles of mowing are not always exactly the same number of days, meaning that it would be difficult to ensure that sampling visits occurred at the same stage in the mowing cycle each time. This variation in the cycle also introduces challenges when comparing the regimes because the floral resource may appear similar when visiting different mowing regimes the same number of days after mowing. In the study described in Chapter 3, bumblebees were seen foraging on clover (*Trifolium spp)* even in a relatively short sward, suggesting that even a moderate reduction in mowing frequency could benefit pollinators by allowing this resource to persist or increase. Similarly, Larson, Kesheimer and Potter (2014), in their study in the USA, found that dandelion (*Taraxacum officinale*) and white clover (*Trifolium repens*) in lawns attracted a range of pollinators, including some which were uncommon. These ‘weed’ species are relatively tolerant to mowing, but the flowers are destroyed, so a longer mowing cycle would increase the resource. Plantlife (2020) suggested that domestic gardeners can provide up to ten times more nectar for pollinators by reducing mowing to once per month in the summer, an increase that is likely to be similar in urban greenspaces. White clover provided the most nectar in lawns, followed by dandelion, though daisies provided the greatest number of flowers (Plantlife, 2019). A greater pollen and nectar resource may support a greater number of pollinators but other factors are important, for example the availability of suitable nesting habitat.

6.4 Human preferences in greenspaces

Human preferences for different features within parks were investigated at the national level (Chapter 4) and their preference for the same specific park habitats as the pollinator study (Chapter 3) were investigated in Chapter 5.

In Chapter 4, crowdsourced ratings of scenicness were compared to different types of greenspace found in the UK. This study showed that natural features and landscapes were considered to be more scenic. Earlier studies which used the same data set, including the images of public greenspaces as well as other locations, also concluded that natural views were considered to be more scenic (Seresinhe,Preis and Moat, 2017; Seresinhe,Moat and Preis, 2018; Seresinhe et al., 2019; Workman,Souvenir and Jacobs, 2017). This suggests that so called ‘naturalistic’ management, which can be cheaper than more formal management approaches, can also be more attractive. Thus park managers may be able to make budgetary savings while having a positive impact public enjoyment of the area.

Some features may be beyond the control of the manager of a greenspace, for example management and use of the surrounding land. Some of the scenic features identified in Chapter 4 could be costly and/or difficult to replicate, for example hills and watercourses. However, there are opportunities to screen unattractive views with vegetation and make the most of attractive views. For example, an attractive view of a church spire could be framed in a gap between two trees or a hedge could reduce the visual impact of a car park. These changes would need to be managed carefully to ensure that sightlines and feelings of security are maintained.

Scenicness is one attribute of amenity in greenspace and other attributes are also important. For example, allotments, which support ecosystem services including food production, and sports facilities which provide opportunities for recreation and exercise, were shown to be unattractive in Chapter 4, but they are still important facilities. The visual impact of less attractive views and man-made features could be minimised by careful design. For example, by choosing styles of ‘park furniture’, such as benches and bins, appropriate for the individual greenspace and siting them with care to minimise any visual impact they may have. It may be appropriate to have lots of park furniture in formal areas and fewer in wilder areas.

In this study, the size of a greenspace had a small but statistically significant positive correlation with scenicness. While small greenspaces such as ‘pocket parks’ and ‘parklets’ do have value in built up areas (Sinou and Perakaki, 2015), park managers should ensure that greenspace users have access to larger spaces where they can get away from noise and air pollution and enjoy open views. For this reason it is important that local planning policies ensure the retention of larger greenspaces and that these areas are not encroached upon by development. The need for larger spaces is also recognised in the Accessible Natural Greenspace Standard (Natural England, 2010). Greenspaces outside of major towns and cities were only slightly more scenic than those inside, which may be due to their more rural views. Careful greenspace planning could lessen the effects of urban views, for example using vegetation to screen less attractive buildings or framing the view of more attractive features.

To further investigate human preferences within greenspaces, in particular floral displays and grass mowing regimes, an open online survey was carried out (Chapter 5). This survey used photographs taken in the first year (2017) of the pollinator study, which helped to minimise biases such as that of investigator bias when images were selected. Use of the images from the pollinator study means that all images were taken in Coventry. Though using photos from one city may limit the transferability of the conclusions it does reduce the effect that location and land owners' individual styles of management could have upon the results.

In the survey, images of three types of mowing were used, short/regularly mown, formal grass mown into stripes, and long/infrequently mown grass. Long grass was the mowing regime most preferred by respondents, followed by short grass. As short grass is required for some activities, such as games, a mixture of these two styles is suggested, and supported by some of the free-text responses in the survey which make the same suggestion. Formal striped lawns were the least preferred and, as they are labour intensive to maintain, this suggests that this style of mowing could be discontinued without impacting negatively upon most visitors. Neat striped lawns are part of a more traditional labour intensive style of management to which park managers are accustomed, or as Sheridan (2017) puts it "the gardenesque paradigm is still imprinted into most people's consciousness when managing green spaces". However, Hoyle *et al.* (2017) found that the public are becoming more accepting of a "messier urban aesthetic" and that park managers are beginning to understand this. Harris *et al.* (2018) found a negative correlation between "lawn" and peoples' preferences, suggesting that lawns were a feature that people did not like. Conversely, Özgüner and Kendle's (2006) list of preferred features in Sheffield's Botanical Gardens indicated that "neat lawns" ranked highly in peoples' preferences, perhaps because lawns are expected in a relatively formal space such as a botanical garden. It could be that visitors see mown grass as a relatively unattractive feature, but necessary for some activities (such as sport and picnics). Further research in activity-specific preferences is needed.

Of the three types of floral display investigated in this study, respondents preferred 'Pictorial Meadows' when they were in full bloom and perennial bedding early in the season. Seasonal bedding was the least preferred, both early in the season and when it was in full bloom. Southon *et al.* (2017) also found that their planted meadows had lower preference scores when not in bloom. The findings presented here suggest that a change from seasonal to perennial bedding will not have a negative impact on the majority of park users. As with striped mowing, mentioned in the previous paragraph, they are part of a traditional "gardenesque paradigm" (Sheridan, 2017) which is perhaps beginning to change (Hoyle *et al.*, 2017). However, in the free text responses to the survey some people pointed out that there is a place for both formal and informal displays. City centre parks, for example, may still be expected to have traditional beds. 'Pictorial Meadows' are usually planted in broad swathes and do not flower early in the season because they consist of a regularly re-seeded annual mix. Perennial beds can provide colour early in the year if early-flowering perennial plants and colourful foliage are included. Hoyle (2015) found that people enjoyed subtle colours such as those provided by varied foliage as well as bright flowers. Seasonal beds are re-planted to provide a long flowering period, but this did not translate into high preference scores. As the form of 'Pictorial Meadows' is so different to traditional beds they should be considered as an addition to bedding, not as a replacement. Whilst colour was mentioned by some respondents as a reason for their preference there appeared to be no key set of colours driving the preference and colourful seasonal bedding still received low preference scores. Hoyle *et al.* (2018) did find a positive relationship between the diversity of flower colour and people's responses, suggesting that park managers should select flowers of a variety of colours.

The characteristics of respondents did not have a large effect on their preferences for floral displays in the survey in Chapter 4. Roth (2006) also found that the effects of demographic factors were small when considering assessments of scenic quality, as were "technological and methodological factors" such as screen definition and the configuration of the online questionnaire. The current study, as well as that of Nam and Dempsey (2019), found a positive correlation between the frequency of greenspace visitation by respondents and their preference for floral meadows. This may be explained by regular visitors becoming more accustomed to this relatively new style of planting in greenspaces. Perhaps preference for this newer planting style will increase as people who visit parks less regularly also become accustomed to the planting.

There can be environmental impacts associated with the regular re-planting of seasonal bedding, such as waste plastic pots, greenhouse gas emissions from transport and possibly peat use which contributes to destruction of peat habitats. Perennial bedding minimises these impacts as it is not regularly re-planted. Due to lower labour and material inputs, perennial bedding is usually cheaper to maintain than seasonal bedding. Mowing grass areas less frequently could also save money through, for example, lower labour and fuel costs. Overall, this study provides strong evidence that greenspace managers could make budgetary savings whilst maintaining spaces that are attractive to visitors.

6.5 Are there trade-offs between pollinators' and humans' preferences in greenspace?

An aim of this research was to identify any trade-offs between management practices in greenspaces which support human enjoyment and those which support biodiversity. Cost effective management of greenspaces which is good for people and wildlife is key due to ongoing government austerity measures. The findings may support park managers in making management decisions which are positive for people and nature, as well as helping them to make budgetary savings.

Based on their study in the USA, Turo and Gardiner (2019) stated that there it is difficult to design pollinator habitats which are acceptable to urban residents, as well as being cost effective. The findings of the current study challenge this view by demonstrating that the features humans enjoy can also be preferred by pollinating insects. This study therefore provides evidence that there need not be a trade-off between humans and pollinators in this aspect of greenspace management. In particular, Turo and Gardiner (2019) found that where residents were not consulted or engaged in plantings, they considered them to be unattractive or even felt unsafe due to the height of the vegetation. In a study by Hoyle, Hitchmough and Jorgensen (2017), in the UK, there was a strong correlation between "perceived attractiveness and perceived insect benefit" suggesting that a planting regime's apparent benefit for wildlife may be a factor in how attractive people find the planting. It is not clear whether the differences in the findings of Turo and Gardiner (2019) when compared to the current study and to that of Hoyle, Hitchmough and Jorgensen (2017) are due to the cultural differences between the USA and the UK or to the nature of the plantings used in each study. In Chapter 3, perennial bedding was shown to be more attractive to pollinators than seasonal bedding. Perennial bedding was also shown to be more attractive to human participants in Chapter 5. This suggests that pollinators and humans have similar preferences between seasonal and perennial bedding. Hoyle *et al.* (2018) found that both pollinators and people found diverse colours in flowers attractive, also supporting that floral displays can be attractive to both groups.

The study presented in Chapter 4, indicated that humans consider natural landscapes to be more scenic; further supporting the view that naturalistic styles of management could benefit both wildlife and people. Southon *et al.* (2017) remarked that other authors (Gobster, 1994; Nassauer, 1995, 2011) have suggested that more natural styles of vegetation are inappropriate in urban greenspaces and that they may be seen as untidy. However, the findings of Southon *et al* support the findings of the current study that the public are accepting of naturalistic vegetation. In Section 2.8.1, in the Exploratory Case Studies section of this study, it was hypothesised that a move to more naturalistic greenspace management due to budgetary constraints could lead to Green Flag Award judging scores that were lower for horticulture but higher for conservation. However, horticulture and conservation scores were shown to have a positive relationship. This supports the finding that what is attractive to people can also be good for conservation. The Green Flag award covers a broad range of standards from community involvement to sustainability. The award is judged by park professionals who have an understanding of parks management and horticulture, so this demonstrates that an increase in management for conservation is not related to a decline in horticultural standards in these sites.

Meadows can also be useful to pollinators and attractive to people. The term ‘meadow style management’ is used here in particular to refer to floral meadow plantings (it can also be used to describe relaxed mowing of grass). Chapter 5 found that participants had high levels of preference for the Pictorial Meadows ‘classic’ mix (a proprietary seed mix) when compared to seasonal bedding, particularly when in full bloom. Southon *et al.* (2017) also demonstrated high public approval of meadow style management. In Chapter 3, in the first year of the study, Pictorial Meadows was in the top four of the fourteen habitats surveyed for both pollinator abundance and species richness. Pictorial Meadows were not included in the second year of the study due to a shortage of suitable replicates in the study sites. Norton *et al.* (2019) also found that insect abundance and order richness was greater in meadow style management than in amenity grass. This shows that meadows are enjoyed by both insects and human greenspace visitors. It is not known how the meadows investigated by Southon *et al.* (2017) and in the current study compare to other meadow mixes and hay meadows (which include grasses and perennial plants).

In general there does not seem to be a trade-off between pollinator biodiversity and visual amenity. Some exceptions could include areas where a short grass sward is necessary, such as sports pitches and very formal town centre parks were traditional bedding may still be expected by visitors. Well managed greenspaces with a diverse range of habitats and management can be attractive to pollinators as well humans.

6.6 The potential for greater innovation in greenspace management

This study has investigated management changes which are already occurring and the effects of these on ecosystem services. There are opportunities for greater innovation in greenspace management, particularly in the development of new parks and greenspaces where there is a ‘clean slate’. An example of a new park is the Queen Elizabeth Olympic Park (2019) in London which was developed in 2012 as part of the Olympic Games legacy. The designers of the Queen Elizabeth Olympic Park aimed to provide a range of ‘green infrastructure’ to support biodiversity, sustainable urban drainage, reduce the urban heat island effect and support transport routes. A new park, Mayfield Park, is planned for Manchester city centre, apparently the first major new UK park since Queen Elizabeth Olympic Park (Walker, 2020). Mayfield Park is also planned to support biodiversity and will include “floodable meadows and biodiverse ecological areas” (Mayfield Manchester, 2020). In another example of innovation, as a means to reduce mowing and increase biodiversity, Smith and Fellowes (2015) trialled “grass-free lawns” forb based lawn mixes which did not include grasses. Forb based lawns required significantly less mowing thereby reducing management costs. These forb mixes required different management approaches to traditional grass lawns. For example, management includes mowing when required, at a specified height, as opposed to mowing to a fixed schedule, as is usually the case with grass. Smith *et al.* (2014) found that these forb based lawns added to the insect diversity of greenspaces. Grass lawns will continue to be required for some uses, in particular sports, but alternatives such as meadows and grassless lawns can be aesthetically attractive as well as promoting biodiversity. There is not a single solution which would work for all parks, or even for all areas of all parks, the challenge is for park managers to choose a selection of management techniques in their parks which are suited to the sites and their communities.

6.7 Critique of methods and suggestions for further work

There has been a broad range of research on landscape preference by humans (as outlined in Chapter 2). There is less research on specific management practices in urban greenspaces and their impact on people and nature, though some authors have begun to tackle these questions. This study builds on the existing research by comparing the preferences of pollinators and people in urban greenspaces. There is still a need for further research in the area of park management and maintenance, particularly in relation to cost effective management which is good for human visitors and for wildlife.

This study examines people’s and pollinator preferences for specific habitats. To fully understand the relationship between the preferences of the providers and beneficiaries of ecosystem services a wider range of habitats and management styles could be investigated. For example, how management of greenspaces impacts upon flooding, air pollution amelioration or the urban heat island effect and how accommodating these additional ecosystem services impacts on recreation. The drivers for the preferences is also an interesting area to examine. For example, colour was one driver for human preference that was examined, others could include the structure of the flower bed/habitat, for example heights of the plants whether the layout is ordered or more random. For the survey in Chapter 5 the range of colours in the images did not predict preference, this suggests that other factors, such as form, were affecting preference. The characteristics of the habitats which makes them attractive to pollinators could also be investigated, for example flower colour and amount of pollen and nectar available. Hoyle *et al.'s* (2018) findings differed from those of this study, they found that both pollinators and people preferred meadows with flowers with a wider range of colours and it would be interesting to investigate this further in other types of floral display.

Further studies could include the effect of a wider range of ecosystem services, for example flood water storage or include a wider range of species of wildlife. This would add to the understanding of the many ecosystem services that parks provide and how these relate to amenity. It would also allow a more appropriate estimate of value to be calculated. Guy Newey (cited in Appleby, 2014) points out that that local authorities often apply a nominal value of £1 to their greenspaces. Better valuation of the resource could lead to better protection and funding.

Due to the varied intervals in mowing in parks it was not possible to fully assess pollinators preferences for different mowing regimes. Trial plots mown at exact intervals would be one way to tackle this issue in a further investigation. This would be challenging to implement in a busy public park so this would need to be implemented at a research site. Flower beds could also have been compared in standardised trial plots at a research site. This has the disadvantage of possibly not accurately representing real life management or other conditions, such as pressure from use, in a greenspace.

In Chapter 3, in the first year of the study, there was a varied number of replicates and not all habitats were available at all of the parks so it was not possible to allow fully for location in the analysis. A larger study over a wider geographical area with several observers it may be able to find a greater number of replicates to reliably compare a greater number of habitats. In this study finding suitable replicates necessitated a narrowing of the focus of the study.

Both Chapter 4 and Chapter 5 used photographs, this has the advantage of allowing people to view a large number of locations and rate them with in a short timeframe. Use of images also allows control over factors such as weather conditions and background features which could affect the results. However, viewing an image is not the same as visiting in person, when the senses other than sight are also involved in the experience. A comparison of on-site and photograph based rating is a potential area for further study.

Chapter 3 was focussed on pollinator preference in parks in the West Midlands, with some comparison to national datasets. Chapter 4 used images from the whole of the UK, but Chapter 5's images came only from the West Midlands (though the respondents were from a wide geographic spread). The results therefore may not apply to the whole of the UK. Management may vary in other areas for the same types of floral display. Investigation of both pollinator and human preferences over a wider geographical area would help to confirm the applicability of the findings to the whole country.

Biases in the survey responses in for Chapter 5 were minimised, for example by varying the order of the questions and the order of the multiple choice responses, which prevents regency and primacy bias where respondents tend to choose the first or last option offered. This was a self-selecting sample however, and as such some bias will remain. Some allowance for this bias was made by analysing the data by demographic group and further studies could include collecting data from a random sample of participants. A random sample could remove the biases introduced here by the self-selecting sample. For example, the respondents chose to fill out a survey regarding greenspaces so presumably they are interested in greenspace, so their responses may differ from those of the wider population.

The actual cost of the different management styles is another interesting area to consider, particularly for park managers. Understanding of the budgetary cost in relation to the environmental and human benefits would further support management decisions. For example, there is not a great deal of data available that compares the actual costs of different mowing regimes. New types of machinery could be required for longer grass lengths caused by longer mowing intervals, therefore budget savings can take time to take effect.

6.8 Conclusion

The research question posed by this study was: are changing management practices in urban parks and greenspaces good for pollinators, and are there trade-offs with amenity? The aim of this project was to investigate how urban parks and greenspaces can be better managed to promote both biodiversity and amenity. This was investigated through the examples of people's visual enjoyment and pollination.

The study findings indicate that both insect pollinators and humans prefer perennial bedding to seasonal bedding. So, with careful management to ensure a long flowering period, a change to perennial bedding could be positive for human visitors as well as pollinators and the ecosystems that they help to support. As the change to perennial bedding has been a cost saving exercise in many cases, this can also help greenspace managers to make budget savings. With regard to mowing regimes, there was generally an acceptance of longer grass by survey respondents, though it is pointed out that short grass is still needed for some activities in greenspace. Traditional 'striped' mowing is labour intensive and is becoming uncommon in public parks but it is still carried out in some high profile sites. Striped mowing received low preference scores. As it is expensive and not liked by the public, greenspace managers should consider discontinuing this style of management. Reduced mowing can help ‘weed’ flowers such as clover (*Trifolium spp)* to persist, providing a nectar and pollen resource. The general public are becoming more tolerant of more natural greenspace management, including ‘weeds’, meaning that these important plants can remain for pollinators.

Natural landscapes were considered scenic in images of greenspace. This suggests that more naturalistic management such as longer grass, meadow style planting and different styles of floral bedding could have a positive impact upon greenspace users. However, there may still be a place for more formal management, for example in some city centre parks where more formal management is still expected.

Overall, the literature and this study demonstrate that what is good for people can also be good for pollinators, if managed well. This research has the potential to inform better greenspace management, under austerity, to benefit both human park users and biodiversity.

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8 APPENDICES

Appendix 1.1: Field instructions card

Weather and timing:

- May, July and September.
- 10:45 and 15:45 (with 10:00 to 17:00 allowable).
- When the weather is warm and “at least bright”.
- There should be “no more than moderate winds” and no rain.
- Either 13-17^{o}C with at least 60% sunshine, or if there is no sunshine the temperature must be 17^{o}C or above.
- Wind speed (Beaufort scale) should be no more than 5 (unless the route is sheltered from the wind)

Quadrat:

- Record weather (using anemometer/thermometer and estimate cloud cover)
- Carry out fixed 2m x 2m quadrats in each floral display type to count pollinator visits to flowers over 5 minutes. (measure area, take a photograph to ensure same area used on next visit).
- Identify flowers (including number of blooms/floral units) at each visit.

Appendix 1.2: Habitat recording form

Site:

	Score
Size of site HA, normalised: =(this site-smallest site)/(Largest site-Smallest site)*10	/10
Forage:	
Spring forage 10 = abundant and diverse plants in flower, 0 = no flowers	/10
Summer forage 10 = abundant and diverse plants in flower, 0 = no flowers	/10
Autumn forage 10 = abundant and diverse plants in flower, 0 = no flowers	/10
Nesting: A=abundant, M=moderate, S=scarce	
Bare ground A=>20%=5, M=5-20%=2-3, S=<5%=1	/5
Unmown/rarely mown areas A=>20%=5, M=5-20%=2-3, S=<5%=0-1	/5
Log piles	/2
Standing dead wood	/2
Hollow stemmed plants	/2
Bee hotel	/2
Management of site:	
% Natural or semi-natural (>75% = 10, 50-75% = 6-7, 25-49% = 4-5, 10-24% = 1-3, <10% = 0)	/10
Close mown % (>75% = 0, 50-75% = 1-2, 25-49% = 3-5, 10-24% = 6-7, <10% = 8-10)	/10
Mixed grass length (does the site have a range of lengths of grass, no=0, 2 or 3 lengths=1-2, various=4-5)	/5

Flower beds (none=0, a few=1-2, frequent throughout site=3-5)	/5
Planted flower mixes (e.g. Pictorial Meadows) (>30% = 10, 20-30% = 7-9, 5-19% = 1-3, <5% = 0)	/10
Flower rich native meadow (>30% = 10, 20-30% = 7-9, 5-19% = 1-3, <5% = 0)	/10
Mixed hedges (none=0, a few=1-2, frequent throughout site=3-5)	/5
Adjacent land use:	
% Natural or semi-natural (>30% = 10, 20-30% = 7-9, 5-19% = 1-3, <5% = 0)	/10
Other:	
Is clean water available (e.g. pond)	/2
Recreation pressure (very busy site, significant trampling=0, few visitors=5)	/5
Total	/130

Xerces score out of 200 (100 = good), for this adaptation score 65/130 = good

Appendix 1.3: Species models

	Dependent variable: Species						
	Negative binomial		*quasipoisson*	*Negative binomial*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Management: Seasonal	-0.657***	-0.654***	-0.654***	-0.786***	-1.026***	-1.022***	-1.029***
	(0.147)	(0.150)	(0.154)	(0.153)	(0.194)	(0.196)	(0.193)
Mean Temp C		0.065	0.065	0.253**	0.077	0.187*	0.058
		(0.072)	(0.074)	(0.101)	(0.070)	(0.105)	(0.078)
Mean MPH		0.061	0.061	0.070	0.086	0.075	0.055
		(0.072)	(0.074)	(0.116)	(0.074)	(0.116)	(0.093)
Mean Cloud %		-0.006	-0.006	0.027**	-0.003	0.024**	-0.004
		(0.005)	(0.005)	(0.011)	(0.005)	(0.011)	(0.005)
Park Campus				-1.002***		-0.736*	
				(0.353)		(0.378)	
Park Coombe				-0.851**		-0.563	
				(0.431)		(0.454)	
Park Greyfriars				-0.901***		-0.734**	
				(0.275)		(0.291)	
Park Jephson				0.073		0.270	
				(0.294)		(0.307)	
Park St Nicholas				0.638*		0.548	
				(0.360)		(0.362)	
Park War Memorial				-1.119***		-0.864**	
				(0.342)		(0.364)	
Bloom No					0.002***	0.001**	0.002***
					(0.0005)	(0.001)	(0.0005)
Habitat Score							0.003
							(0.006)
Constant	1.322***	0.144	0.144	-4.149*	-0.392	-3.036	-0.115
	(0.086)	(1.471)	(1.509)	(2.195)	(1.447)	(2.230)	(1.520)
Observations	72	72	72	72	72	72	72
Log Likelihood	-135.648	-133.641		-125.543	-128.189	-123.420	-128.036
Theta	11,835.290 (449,221.200)	28,424.410 (553,705.500)		51,502.440 (755,001.100)	35,680.640 (491,065.000)	50,266.010 (671,604.600)	36,769.950 (509,693.400)
Akaike Inf. Crit.	275.296	277.282		273.087	268.377	270.841	270.073

0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Appendix 1.4: Individual models

	Dependent variable: Individuals						
	Negative binomial		*quasipoisson*	*Negative binomial*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Management: Seasonal	-1.072***	-1.050***	-1.123***	-1.472***	-1.835***	-1.796***	-1.839***
	(0.244)	(0.244)	(0.329)	(0.218)	(0.277)	(0.258)	(0.278)
Mean Temp C		0.203	0.292**	0.588***	0.198*	0.484***	0.187
		(0.132)	(0.125)	(0.171)	(0.119)	(0.170)	(0.130)
Mean MPH		0.126	0.199	0.158	0.194*	0.199	0.176
		(0.123)	(0.142)	(0.164)	(0.114)	(0.158)	(0.143)
Mean Cloud %		-0.007	-0.003	0.039**	0.003	0.038**	0.003
		(0.008)	(0.010)	(0.016)	(0.007)	(0.016)	(0.008)
Park Campus				-2.419***		-1.942***	
				(0.510)		(0.530)	
Park Coombe				-1.869***		-1.390**	
				(0.619)		(0.637)	
Park Greyfriars				-1.613***		-1.339***	
				(0.392)		(0.397)	
Park Jephson				-0.793*		-0.364	
				(0.426)		(0.433)	
Park St Nicholas				0.521		0.436	
				(0.544)		(0.530)	
Park War Memorial				-1.936***		-1.521***	
				(0.475)		(0.500)	
Bloom No					0.003***	0.002**	0.003***
					(0.001)	(0.001)	(0.001)
Habitat Score							0.002
							(0.009)
Constant	2.659***	-1.395	-3.351	-9.339**	-2.041	-7.793**	-1.865
	(0.167)	(2.700)	(2.620)	(3.630)	(2.449)	(3.556)	(2.559)
Observations	72	72	72	72	72	72	72
Log Likelihood	-230.461	-227.853		-213.145	-218.691	-210.752	-218.677

theta	1.070*** (0.196)	1.162*** (0.218)		1.869*** (0.394)	1.549*** (0.312)	2.036*** (0.440)	1.550*** (0.312)
Akaike Inf. Crit.	464.923	465.707		448.290	449.383	445.503	451.354

0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Appendix 1.5: Bumblebee models

A: Bumblebee species/groups

```
Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.6159  -1.1547  -0.2790   0.5632   2.0875

Coefficients:
                            Estimate Std. Error z value Pr(>|z|)
(Intercept)                   0.2666     0.1459   1.828  0.06757 .
ALL2018P$ManagementSeasonal  -0.6721     0.2509  -2.679  0.00739 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for Negative Binomial(14939.17) family taken to be
1)

    Null deviance: 75.116  on 71  degrees of freedom
Residual deviance: 67.529  on 70  degrees of freedom
AIC: 180.88

Number of Fisher Scoring iterations: 1


              Theta:  14939
          Std. Err.:  253564

 2 x log-likelihood:  -174.877
```

B: Bumblebee individuals

```
Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.7884  -1.2279  -0.4808   0.5280   1.6620

Coefficients:
                            Estimate Std. Error z value Pr(>|z|)
(Intercept)                   1.2840     0.1816   7.071 1.54e-12 ***
ALL2018P$ManagementSeasonal  -1.2040     0.2897  -4.157 3.23e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for Negative Binomial(1.0986) family taken to be
1)

    Null deviance: 95.036  on 71  degrees of freedom
Residual deviance: 77.511  on 70  degrees of freedom
AIC: 283.36
```

```
Number of Fisher Scoring iterations: 1


              Theta:  1.099
          Std. Err.:  0.322

 2 x log-likelihood:  -277.355
```

Appendix 1.6: Mixed effects Negative Binomial model, species

```
Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) ['glmerMod']
 Family: Negative Binomial(81883.7)  ( log )
Formula: ALL2018P$Species ~ ALL2018P$Management + ALL2018P$MeanTempC +
ALL2018P$MeanMPH + ALL2018P$`MeanCloud%` + (1 | ALL2018P$Park)

     AIC      BIC   logLik deviance df.resid
   279.3    295.2   -132.6    265.3       65

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.5261 -0.7650 -0.1755  0.5957  2.7823

Random effects:
 Groups        Name        Variance Std.Dev.
 ALL2018P$Park (Intercept) 0.003572 0.05977
Number of obs: 72, groups:  ALL2018P$Park, 7

Fixed effects:
                             Estimate Std. Error z value Pr(>|z|)
(Intercept)                  0.041410   1.295984   0.032    0.975
ALL2018P$ManagementSeasonal -0.658300   0.151206  -4.354 1.34e-05 ***
ALL2018P$MeanTempC           0.069051   0.062300   1.108    0.268
ALL2018P$MeanMPH             0.060364   0.073561   0.821    0.412
ALL2018P$`MeanCloud%`       -0.005894   0.005805  -1.015    0.310
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) ALL2018P$MS ALL2018P$MT ALL2018P$MM
ALL2018P$MS  0.155
ALL2018P$MT -0.985 -0.189
ALL2018P$MM -0.150  0.071       0.062
ALL2018P$`M -0.349 -0.144       0.224       0.000
```

Appendix 1.7: Mixed effects Negative Binomial model, individuals

```
Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) ['glmerMod']
 Family: Negative Binomial(1.5445)  ( log )
Formula: ALL2018P$Individuals ~ ALL2018P$Management + ALL2018P$MeanTempC
+      ALL2018P$MeanMPH + ALL2018P$`MeanCloud%` + (1 | ALL2018P$Park)

     AIC      BIC   logLik deviance df.resid
   460.2    476.1   -223.1    446.2       65

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.0736 -0.7188 -0.2204  0.4441  4.8305

Random effects:
 Groups        Name        Variance Std.Dev.
 ALL2018P$Park (Intercept) 0.2909   0.5394
Number of obs: 72, groups:  ALL2018P$Park, 7

Fixed effects:
                             Estimate Std. Error z value Pr(>|z|)
(Intercept)                 -5.221742   3.476567  -1.502   0.1331
ALL2018P$ManagementSeasonal -1.280729   0.239464  -5.348 8.88e-08 ***
ALL2018P$MeanTempC           0.367422   0.161505   2.275   0.0229 *
ALL2018P$MeanMPH             0.133641   0.167808   0.796   0.4258
ALL2018P$`MeanCloud%`        0.008913   0.014615   0.610   0.5419
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) ALL2018P$MS ALL2018P$MT ALL2018P$MM
ALL2018P$MS  0.322
ALL2018P$MT -0.987 -0.338
ALL2018P$MM -0.212  0.068       0.122
ALL2018P$`M -0.551 -0.320       0.446       0.169
```

Appendix 1.8: Species/groups by month negative binomial

	Dependent variable: Species		
	May	July	September
Management Seasonal	-1.158**	-0.873***	-0.561*
	(0.380)	(0.208)	(0.249)
Temp C	-0.163*	0.002	-0.640
	(0.090)	(0.043)	(0.509)
Wind MPH	0.023	-0.076	0.032
	(0.120)	(0.088)	(0.047)
Cloud %	-0.019	-0.018	0.004
	(0.020)	(0.018)	(0.003)
Constant	2.904	0.625	10.629
	(1.822)	(1.068)	(8.698)
Observations	95	108	105
Log Likelihood	-79.615	-144.359	-126.606
theta	6.011 (13.697)	101.004 (1,305.564)	4.115 (3.591)
Akaike Inf. Crit.	169.229	298.718	263.212
Note:	0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1		

	Dependent variable: Individuals		
	May	July	September
Management Seasonal	-1.299**	-1.301***	-0.782*
	(0.417)	(0.358)	(0.307)
Temp C	-0.162	0.033	-0.723
	(0.126)	(0.081)	(0.587)
Wind MPH	-0.052	0.080	0.037
	(0.156)	(0.163)	(0.061)
Cloud %	-0.028	0.008	0.006
	(0.023)	(0.032)	(0.004)
Constant	3.651	1.023	12.583
	(2.545)	(2.012)	(10.041)
Observations	95	108	105
Log Likelihood	-102.815	-246.469	-167.468
theta	0.574** (0.229)	0.391*** (0.068)	0.681*** (0.175)
Akaike Inf. Crit.	215.630	502.938	344.935
Note:	0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1		

Appendix 1.9: Individuals by month negative binomial

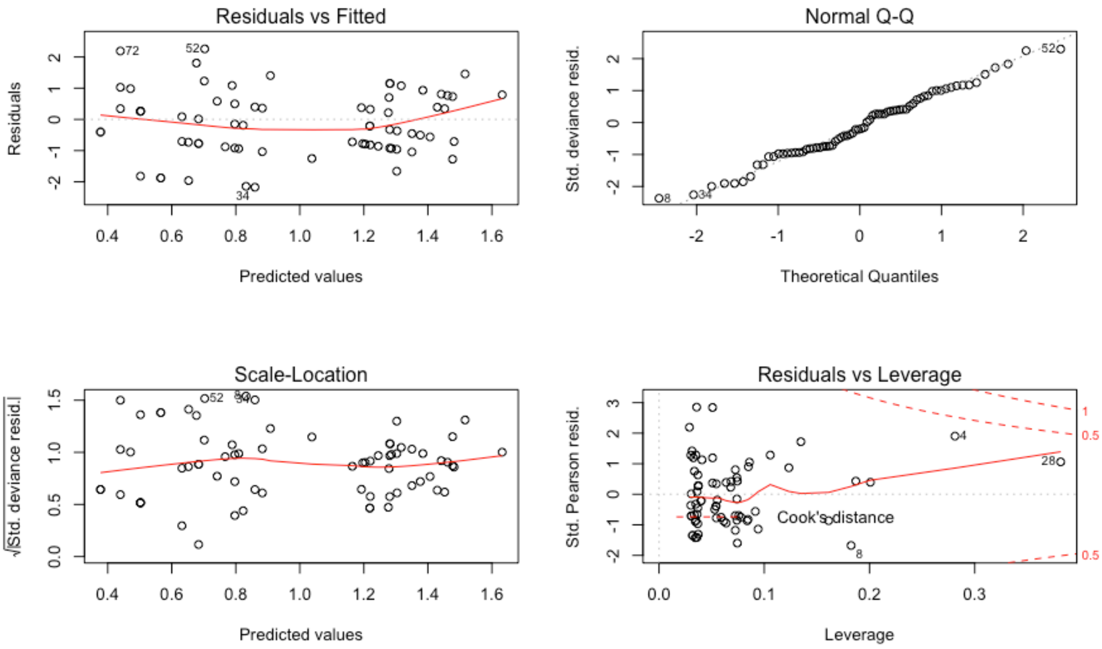
Appendix 1.10: Mixed Effect Models by Month

```
> summary(SpeciesMMNBMonth)
Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) ['glmerMod']
 Family: Negative Binomial(233768.1)  ( log )
Formula:   ALL2018MonthSite$Species   ~   ALL2018MonthSite$Management   +
ALL2018MonthSite$MeanTempC +
    ALL2018MonthSite$MeanMPH + ALL2018MonthSite$`MeanCloud%` +
    (1 | ALL2018MonthSite$Month) + (1 | ALL2018MonthSite$Site)

     AIC      BIC   logLik deviance df.resid
   181.5    195.4    -82.7    165.5       34

Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.27029 -0.65435 -0.04441  0.54297  1.95971

Random effects:
 Groups                 Name        Variance Std.Dev.
 ALL2018MonthSite$Site  (Intercept) 0.06836  0.2615
 ALL2018MonthSite$Month (Intercept) 0.12812  0.3579
Number    of    obs:    42,    groups:       ALL2018MonthSite$Site,    7;
ALL2018MonthSite$Month, 3

Fixed effects:
                                     Estimate Std. Error z value Pr(>|z|)
(Intercept)                          1.108541   0.824331   1.345 0.178698
ALL2018MonthSite$ManagementSeasonal -0.656249   0.171628  -3.824 0.000131
***
ALL2018MonthSite$MeanTempC           0.009710   0.040160   0.242 0.808953
ALL2018MonthSite$MeanMPH             0.049892   0.058164   0.858 0.391016
ALL2018MonthSite$`MeanCloud%`        0.003174   0.004115   0.771 0.440451
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
             (Intr) ALL2018MS$MS ALL2018MS$MT ALL2018MS$MM
ALL2018MS$MS  0.051
ALL2018MS$MT -0.938 -0.125
ALL2018MS$MM -0.246  0.022        0.172
ALL2018MS$`  -0.167 -0.049        0.045       -0.212
>     IndivMMNBMonth     <-     glmer.nb(ALL2018MonthSite$Individuals     ~
ALL2018MonthSite$Management +  ALL2018MonthSite$MeanTempC +
+                                          ALL2018MonthSite$MeanMPH  +
ALL2018MonthSite$`MeanCloud%`   +   (1   |   ALL2018MonthSite$Month)   +   (1|
ALL2018MonthSite$Site))
Warning message:
In glmer.nb(ALL2018MonthSite$Individuals ~ ALL2018MonthSite$Management +  :
  no 'data = *' in glmer.nb() call ... Not much is guaranteed
> summary(IndivMMNBMonth)
Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) ['glmerMod']
 Family: Negative Binomial(2.9385)  ( log )
Formula: ALL2018MonthSite$Individuals ~ ALL2018MonthSite$Management +
```

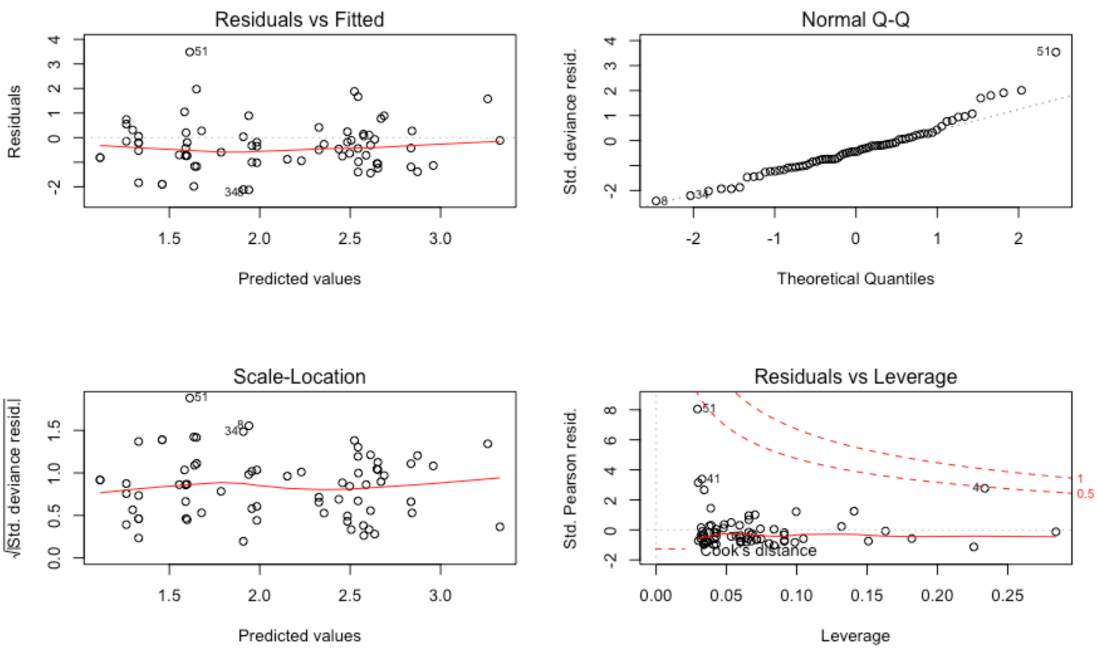
```
    ALL2018MonthSite$MeanTempC      +      ALL2018MonthSite$MeanMPH      +
ALL2018MonthSite$`MeanCloud%` +
    (1 | ALL2018MonthSite$Month) + (1 | ALL2018MonthSite$Site)

     AIC      BIC   logLik deviance df.resid
   295.7    309.6   -139.8    279.7       34

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.5542 -0.6008 -0.1060  0.3640  1.9493

Random effects:
 Groups                 Name        Variance Std.Dev.
 ALL2018MonthSite$Site  (Intercept) 0.3973   0.6303
 ALL2018MonthSite$Month (Intercept) 0.9496   0.9745
Number    of    obs:    42,    groups:       ALL2018MonthSite$Site,    7;
ALL2018MonthSite$Month, 3

Fixed effects:
                                     Estimate Std. Error z value Pr(>|z|)
(Intercept)                          2.960295   1.607290   1.842   0.0655 .
ALL2018MonthSite$ManagementSeasonal -1.249978    0.229691   -5.442 5.27e-08
***
ALL2018MonthSite$MeanTempC          -0.027336   0.072625  -0.376   0.7066
ALL2018MonthSite$MeanMPH             0.036805   0.083026   0.443   0.6575
ALL2018MonthSite$`MeanCloud%`        0.009307   0.006127   1.519   0.1287
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
             (Intr) ALL2018MS$MS ALL2018MS$MT ALL2018MS$MM
ALL2018MS$MS  0.106
ALL2018MS$MT -0.912 -0.170
ALL2018MS$MM -0.264  0.001        0.233
ALL2018MS$`  -0.187 -0.104        0.102       -0.215
```

Appendix 1.11: Diagnostic Plots

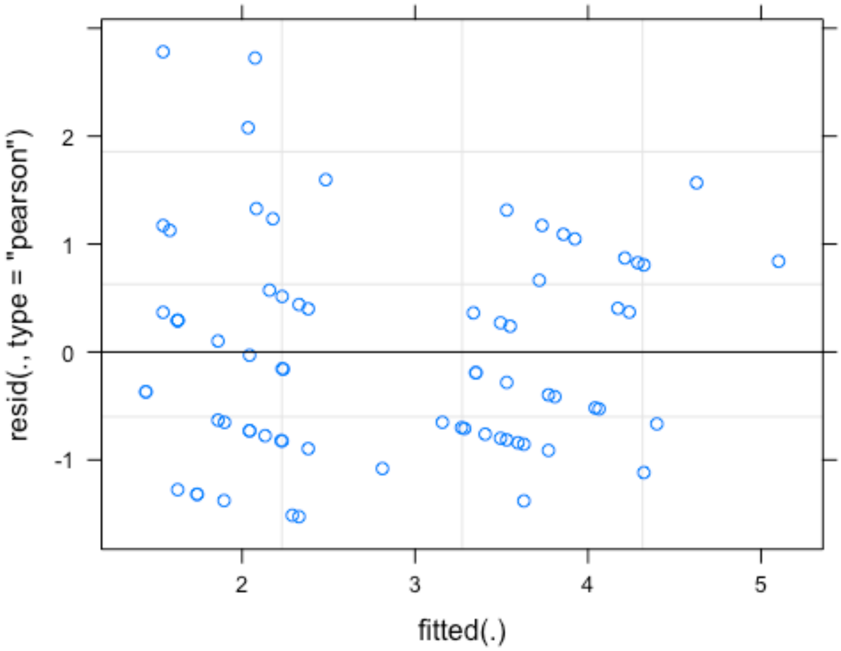
Negative Binomial: Management, weather, species



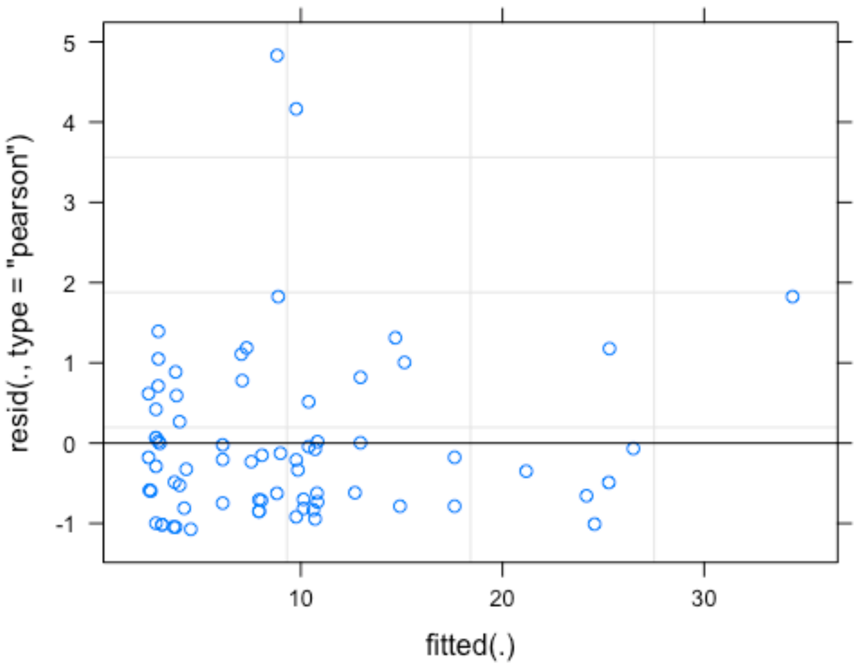
Negative Binomial: Management, weather, individuals



Mixed Model, Species



Mixed model: Individuals



Appendix 2.1: Reducing no of Geograph categories:

Stage one: categories and their photographs which were removed completely, as category suggests main features not representative of a public park/greenspace. E.g. removed all categories where building, excepting park/sport buildings, is dominant feature. * indicates that all categories containing this word/string were removed:

A road
Abbey
Airfield
Alley
Almshouses
Ambulance station
Animal welfare building
Apartment block
Art deco
Art Gallery
B road
Bank (building)
Barn
Barracks
B&B
Beehives
Brownfield site
Build*
Bus *
Business
building
Campsite
Car *
Castle
Cathedral
Cattle market
Chapel
Chemist
Chimneys
Church *
Clock tower
Close
Clubhouse
Cold War relic
College
Colliery
Communications mast
Community buildings
Community centre
Conference Centre
Cottage
Construction *
Council offices
Country road
Crematorium
Croft
Crossroads
Cul de sac
Derelict
Doctor
Dual carriageway
Education centre
Electricity pylons
Environmental damage
Factory
Film and TV sets
Fire station
Flats
Flood*
Fort*
Funeral director
Gallops
Garages
Garden centre
Gasometer
Graffiti
Hairdresser
Hall of residence
Hamlet
Holiday*
Hospital
Hot air balloon
Hotel
house
Industrial*
Inn
Kirk
Lane*
Lay-by
Leisure centre
Level crossing
Library
Lodge
Masts
Mausoleum
Mechanics institute
*Mill
Mine
MOD
Monastery
Motel
Motorway*
Museum
Nursery
Nursing home
Observatory
Office
Oil refinery
Outbuildings
Outdoor centre
Parade
Pedestrianised area
Petrol station
Pillboxes
Police station
Post office
Post box
Powerlines
Priory
Prison
Public convenience
Public house
Pump*
Pylons
Quarry
Radio mast
RAF base
Railway*
Rectory
Religious*
Residential
Restaurant
Retail*
Road*
Roofscape
Roundabout
Rubbish tip
Scarecrows
Scheduled monument
School
Scout hut
Shooting lodge
Shop*
Signs
Social club
Speed camera
Stables
Steam*
Stores
street
Tower*
Town*
Traffic
Training centre
Train
Tram*
Transmitter
Traps
Trolleybus
University
Vandalised motor vehicle
Verge
Vicarage
Village*
Warehouse
Wartime relics
Waste ground
Waste recycling centre
Well
Windmill
Work*
Yard
Youth hostel

Features changed in second stage, based on photograph category

Original Category	New Category
Animal farm and leisure park	Pasture
Animal husbandry	Pasture
Aqueduct	Bridge
Arable land	Arable
Arable land	Arable
Arboretum	Trees
Archaeology	Historic
Architectural feature	Park building
Athletic / running track	Sport
Autumn tree colour	Trees
Avenue	Trees
Bandstand	Park building
Bank (sloping land)	Pasture
Barrows	Moorland
Bay	Coastal
Beach	Coastal
Beck	Watercourse
Belvedere	Historic
Boat	Waterbody
Boating lake	Waterbody
Botanical gardens	Gardens
Bowling green	Sport
Bowling green (disused)	Sport
Bowls club	Sport
Bowls club	Sport
Bridleway	Path
Brook	Watercourse
Burn	Watercourse
Café	Park building
Canal bridge	Canal
Canal locks	Canal
Canal marina	Canal
Canal towpath	Canal
Canal tunnel	Canal
Canal wharf	Canal
Cattle	Pasture
Cattle grid	Pasture
Cemetery	Burial ground
Churchyard	Burial ground
Churchyard	Burial ground
Circus (travelling entertainers)	Event
Clearing	Woodland
Coastal defences	Coastal
Coastal path	Coastal
Coastal scenery	Coastal

Coastguard Station	Coastal
Coastline/Beaches	Coastal
Coastline/Beaches	Coastal
Combe or coomb or coombe	Hill
Confluence	Watercourse
Copse	Woodland
Country house	Country estate
Countryside activity	Event
Court	Country estate
Crags	Hill
Creek	Watercourse
Cricket field	Sport
Cricket pavilion	Park building
Crops	Arable
Croquet lawns	Sport
Culvert	Watercourse
Curiosity	Historic
Cycle circuit	Sport
Cycle trail	Path
Cycleway	Path
Dam	Waterbody
Deer	Parkland
Deer park	Parkland
Dew pond	Waterbody
Doocot	Historic
Doocot / Dovecote	Historic
Dovecot	Historic
Downland	Moorland
Dunes	Coastal
Dyke	Watercourse
Estuary, Marine	Coastal
Event	Event
Fair	Event
Farm	Pasture
Farm road	Track
Farm, Fishery, Market Gardening	Arable
Farm, Fishery, Market Gardening	Pasture
Farming activity	Arable
Farming activity	Arable
Farmland	Arable
Farmland	Pasture
Farmland	Pasture
Fells	Hill
Festival	Event
Field	Pasture
Field / woodland boundary	Arable
Field / woodland boundary	Pasture

Field boundaries	Pasture
Fields	Arable
Fields	Arable
Fields	Pasture
Fishery	Waterbody
Fishing	Waterbody
Fishing	Waterbody
Fishing lake	Waterbody
Fishing pond	Waterbody
Flash	Waterbody
Flyover	Bridge
Folly	Historic
Football ground	Sport
Football match	Sport
Football pitches	Sport
Footpath junction	Path
Ford	Watercourse
Foreshore	Coastal
Forest	Woodland
Forest clearing	Woodland
Forest walks	Woodland
Forestry	Woodland
Forestry clear fell	Woodland
Forestry road	Woodland
Fountains	Park
Gate	Entrance
Gate entrance	Entrance
Gateway	Entrance
Gazebo	Historic
Glacial feature	Hill
Golf driving range	Golf course
Golf putting green	Golf course
Gravel pits	Waterbody
Graves	Burial ground
Gravestones	Burial ground
Graveyard	Burial ground
Grazing land	Pasture
Grouse moor	Moorland
Ha-ha	Historic
Hall	Country estate
Heathland	Moorland
Hedge	Trees
Hill fort	Hill
Hills	Hill
Hillside	Hill
Historic building	Historic
Historic site	Historic

Historic sites and artefacts	Historic
Historical item	Historic
Holloway	Path
Horse riding	Event
Horses	Pasture
Island	Waterbody
Jetty	Waterbody
Kissing gate	Path
Lade	Waterbody
Lake	Waterbody
Lakes, Wetland, Bog	Waterbody
Landing stage	Waterbody
Lighthouse	Coastal
Livestock	Pasture
Loch	Waterbody
Long Distance Footpath	Path
Manor house	Country estate
Mansion	Country estate
Marina	Coastal
Memorial gardens	Gardens
Milepost	Historic
Milestone	Historic
Millpond	Waterbody
Monument	Memorial
Motte	Historic
Mound	Hill
Mountains	Hill
Mountainside	Hill
Music festival	Event
National Cycle Network route	Path
National Trail	Path
National Trust property	Country estate
Obelisk	Memorial
Obelisk	Memorial
Open countryside	Parkland
Packhorse bridge	Bridge
Paddling pool	Park
Paddocks	Pasture
Palace	Country estate
Park and Public Gardens	Gardens
Park and Public Gardens	Park
Pasture land	Pasture
Pasture land	Pasture
Pavilion	Park building
Peat haggs	Moorland
Penstocks	Watercourse
Permissive Footpath	Path

Permissive path	Path
Picnic area	Park
Picnic area	Play area
Piers	Coastal
Pig farm	Pasture
Plantation	Woodland
Plaque	Memorial
Playground	Play area
Playpark	Play area
Pond	Waterbody
Ponds	Waterbody
Ponies	Pasture
Pools	Waterbody
Promenade	Coastal
Public bridleway	Path
Public footpath	Path
Public open space	Park
Public park	Park
Rainbow	Park
Reclaimed land	Park
Recreational Route	Path
Reservoir	Waterbody
Reservoir (disused)	Waterbody
Reservoir outflow	Waterbody
Reservoir spillway	Waterbody
Ride	Woodland
River bank	Watercourse
River scene	Watercourse
River valley	Watercourse
Rivers, Streams, Drainage	Watercourse
Rough grazing	Pasture
Rowing club	Waterbody
Rugby ground	Sport
Ruins	Historic
Sailing club	Waterbody
Sailing club	Waterbody
Sand dunes	Coastal
Sculpture	Park
Sea loch	Coastal
Seats	Park
Sheep	Pasture
Sheep pens	Pasture
Shoreline	Coastal
Showground	Event
Signpost	Path
Skate park	Play area
Ski centre	Sport

Sluice gate	Watercourse
Sluices	Watercourse
Snowscene	Gardens
Snowscene	Park
Sport, Leisure	Sport
Sports events	Event
Sports facility	Sport
Sports ground	Sport
Sports pavilion	Park building
Sports stadium	Sport
SSSI	Nature reserve
Standing stones	Historic
Stately home	Country estate
Statues	Memorial
Stepping stones	Watercourse
Steps	Path
Stile	Path
Stocks	Historic
Stone	Historic
Stone circle	Historic
Stream	Watercourse
Suburb, Urban fringe	Park
Summit	Trig Point
Sunrise	Park
Tearoom	Park building
Temple	Park building
Tennis club	Park building
Tennis courts	Sport
Tents	Event
Tidal creek	Watercourse
Toposcope	Trig Point
Towpath	Canal
Track junction	Track
Tree	Trees
Tree stump	Trees
Tree-lined road	Trees
Trees	Trees
Trees	Trees
Triangulation Pillar	Trig Point
Tumulus	Hill
Underpass	Bridge
Uplands	Hill
Urban fringe	Park
Valley	Moorland
Valley	Park
View	Park
Viewpoint	Park

Village green	Green
Village pond	Waterbody
Visitor centre	Park building
Walkway	Path
Walled garden	Gardens
War Graves	Burial ground
War Memorial	Memorial
Water flow gauging station	Watercourse
Water sports	Waterbody
Watercourse	Watercourse
Waterfalls	Watercourse
Waterpark	Waterbody
Waterworks	Park
Weir	Watercourse
Wildlife	Park
Wildlife reserve	Nature reserve
Wood	Woodland
Woodland, Forest	Woodland
Woods	Woodland

Photographs changed in third stage, categories with less than 10 photographs changed by OS category and/or examination of the photograph.

Original Category	New Category
Amphitheatre	Country park
Ancient mound	Common
Ancient mound	Golf course
Ancient site	Country park
Beacon	Coastal
Bird hide	Country park
Birds	Golf course
Birds	Park
Bog	Woodland
Boom	Canal
Boundary	Hill
Boundary posts	Path
Boundary stone	Woodland
Boundary, Barrier	Track
Boundary, Barrier	Woodland
Cairn	Country park
Canoes and canoeing	Country park
Carving	Country park
Carving	Park
Caves	Golf course
Chalk quarry (disused)	Park
Cityscape	Park
Closeup	Waterbody
Coal Tax Post	Coastal
Cottage	Woodland
Countryside	Country park
Countryside	Pasture
Drain	Watercourse
Drain	Watercourse
Driveway	Track
Dry stone wall	Hill
Dry stone wall	Moorland
Earthworks	Park
Embankments	Park
Ferry	Watercourse
Flora	Woodland
Gill	Woodland
Goit	Golf course
Grassland	Common
Grounds	Golf course
Hedge	Track
Hide	Park
Land drain	Watercourse

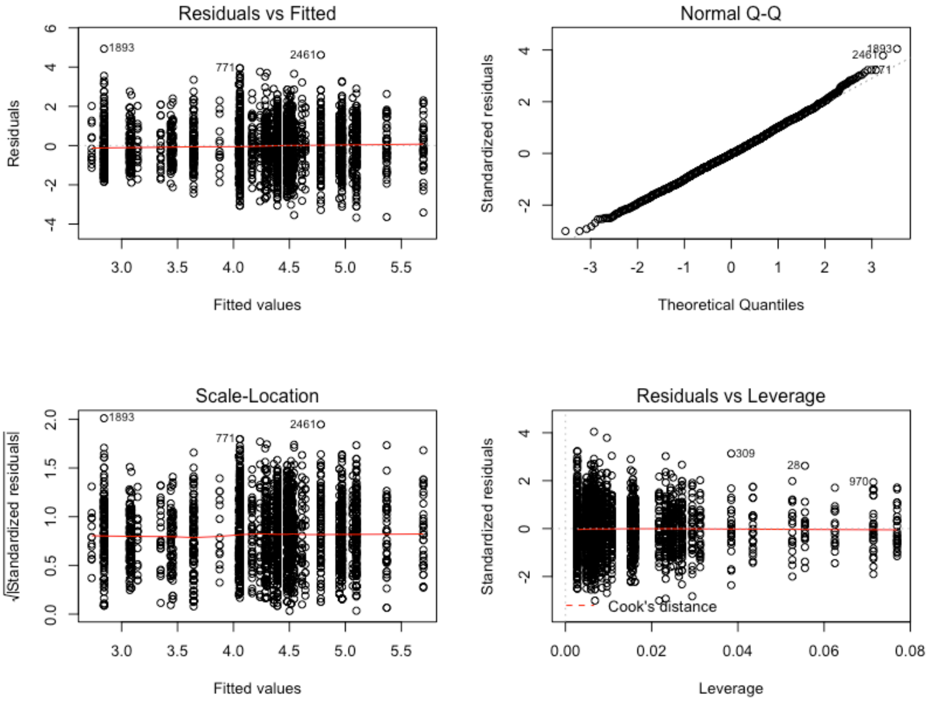
Landmark	Country park
Landscape	Hill
Landscape	Playing field
Landscape	Watercourse
Marker	Path
Marshland	Country park
Marshland	Playing field
Maypole	Playing field
Meadows	Country park
Meadows	Nature reserve
Meadows	Park
Meadows	Pasture
Mossland	Nature reserve
National Park	Country park
Natural arch	Country park
Nature trail	Woodland
Open countryside	Parkland
Open land	Park
Open land	Playing field
Open space	Park
Open space	Playing field
Paddling pool	Park
Panorama	Playing field
Parish hall	Playing field
Park and Public Gardens	Country park
Picnic area	Common
Picnic area	Park
Picnic area	Waterbody
Public artwork	Recreation ground
Railway (dismantled)	Path
Railway (disused)	Path
Rainbow	Park
Reclaimed land	Country park
Reclaimed land	Park
Rock outcrops	Park
Rural scene	Parkland
Rural urban fringe	Playing field
Rural view	Parkland
Sculpture	Country park
Sculpture	Park
Sculpture	Woodland
Seats	Country park
Seats	Park
Sheds	Golf course
Shelter belt	Pasture
Slipway	Watercourse

Smallholding	Pasture
snow	Playing field
Snowscene	Burial ground
Snowscene	Country park
Snowscene	Golf course
Snowscene	Moorland
Snowscene	Park
Snowscene	Playing field
Snowscene	Woodland
Suburb, Urban fringe	Park
Sunrise	Golf course
Sunrise	Park
Sunset	Golf course
Tourist attraction	Golf course
Tunnel	Canal
Urban fringe	Country park
Urban fringe	Park
Valley	Country park
Valley	Golf course
Valley	Moorland
Valley	Park
Valley	Path
Valley	Woodland
View	Coastal
View	Country park
View	Moorland
View	Park
View	Pasture
Viewpoint	Park
Viewpoint	Waterbody
Wall	Burial ground
Wall	Country park
Water feature	Pasture
Water feature	Watercourse
Waterworks	Park
Weather	Park
Wildlife	Country park
Wildlife	Park

Appendix 2.2: Linear regression

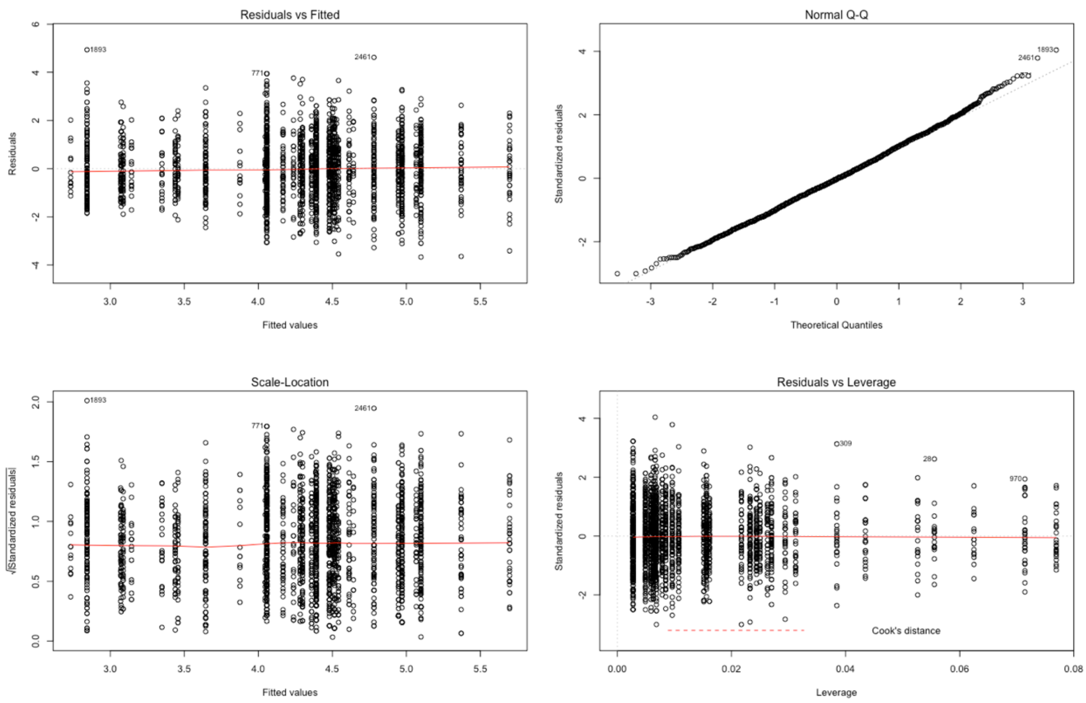
```
Call:
lm(formula       =       ParkVotesReduce$AveVote        ~
ParkVotesReduce$NewCategory2)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.6699 -0.8032 -0.0285  0.7904  4.9350 

Coefficients:
                                              Estimate
Std. Error t value Pr(>|t|)
(Intercept)                                    4.48010
0.09716  46.109  < 2e-16 ***
ParkVotesReduce$NewCategory2Country park       0.03398
0.14887   0.228 0.819460
ParkVotesReduce$NewCategory2Nature reserve    -0.09258
0.29740  -0.311 0.755608
ParkVotesReduce$NewCategory2Allotments        -1.41029
0.35343  -3.990 6.79e-05 ***
ParkVotesReduce$NewCategory2Arable            -0.43396
0.30469  -1.424 0.154492
ParkVotesReduce$NewCategory2Bridge            -0.19685
0.17940  -1.097 0.272632
ParkVotesReduce$NewCategory2Burial ground     -0.83606
0.14581  -5.734 1.10e-08 ***
ParkVotesReduce$NewCategory2Canal              0.04824
0.22123   0.218 0.827392
ParkVotesReduce$NewCategory2Coastal            0.88975
0.20512   4.338 1.50e-05 ***
ParkVotesReduce$NewCategory2Common            -0.24286
0.25918  -0.937 0.348838
ParkVotesReduce$NewCategory2Country estate    -0.12051
0.18137  -0.664 0.506475
ParkVotesReduce$NewCategory2Entrance          -1.02305
0.22363  -4.575 5.01e-06 ***
ParkVotesReduce$NewCategory2Event             -1.33687
0.32134  -4.160 3.29e-05 ***
ParkVotesReduce$NewCategory2Gardens            0.13308
0.22363   0.595 0.551848
ParkVotesReduce$NewCategory2Golf course       -0.42317
0.11652  -3.632 0.000287 ***
ParkVotesReduce$NewCategory2Green             -0.60417
0.34156  -1.769 0.077043 .
ParkVotesReduce$NewCategory2Hill               1.21677
0.23150   5.256 1.60e-07 ***
```

```
ParkVotesReduce$NewCategory2Historic                  0.02119
0.18137   0.117 0.907021
ParkVotesReduce$NewCategory2Memorial                 -1.04105
0.21460  -4.851 1.31e-06 ***
ParkVotesReduce$NewCategory2Moorland                  0.58617
0.23738   2.469 0.013605 *
ParkVotesReduce$NewCategory2Park building            -1.39277
0.21672  -6.427 1.56e-10 ***
ParkVotesReduce$NewCategory2Parkland                  0.46682
0.18345   2.545 0.010996 *
ParkVotesReduce$NewCategory2Pasture                  -0.18203
0.15994  -1.138 0.255191
ParkVotesReduce$NewCategory2Path                     -0.08886
0.12975  -0.685 0.493521
ParkVotesReduce$NewCategory2Play area                -1.74770
0.35343  -4.945 8.13e-07 ***
ParkVotesReduce$NewCategory2Playing field            -1.40668
0.21460  -6.555 6.77e-11 ***
ParkVotesReduce$NewCategory2Recreation ground        -1.13103
0.27332  -4.138 3.62e-05 ***
ParkVotesReduce$NewCategory2Sport                    -1.63731
0.13922 -11.761  < 2e-16 ***
ParkVotesReduce$NewCategory2Track                    -0.31343
0.21059  -1.488 0.136798
ParkVotesReduce$NewCategory2Trees                     0.06163
0.21059   0.293 0.769819
ParkVotesReduce$NewCategory2Trig Point                0.16212
0.34156   0.475 0.635084
ParkVotesReduce$NewCategory2Waterbody                 0.48982
0.13536   3.619 0.000302 ***
ParkVotesReduce$NewCategory2Watercourse               0.61844
0.14044   4.404 1.11e-05 ***
ParkVotesReduce$NewCategory2Woodland                  0.30052
0.15451   1.945 0.051899 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1
‘ ’ 1

Residual standard error: 1.225 on 2443 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared:  0.2228,  Adjusted R-squared:  0.2123
F-statistic: 21.22 on 33 and 2443 DF,  p-value: < 2.2e-16
```


Residuals vs Fitted
Residuals
Fitted values
Normal Q-Q
Standardized residuals
Theoretical Quantiles
Scale-Location
√|Standardized residuals|
Fitted values
Residuals vs Leverage
Standardized residuals
Cook's distance
Leverage

Appendix 2.3: Analysis of Variance and Tukey HSD

```
anva                                                  <-
aov(ParkVotesReduce$AveVote~ParkVotesReduce$NewCategory2
)
summary(anva)
                                Df  Sum Sq Mean Sq F value
Pr(>F)
ParkVotesReduce$NewCategory2    33    1051    31.85   21.22
<2e-16 ***
Residuals                     2443    3667     1.50
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1
' ' 1
```



Tukey HSD

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TukeyHSD(anva, conf.level = 0.99)
  Tukey multiple comparisons of means
    99% family-wise confidence level

Fit: aov(formula = ParkVotesReduce$AveVote ~ ParkVotesReduce$NewCategory2)

$`ParkVotesReduce$NewCategory2`
                                         diff           lwr          upr     p adj
Country park-Park                 0.033981601 -0.5976598435  0.665623046 1.0000000
Nature reserve-Park              -0.092576829 -1.3544187106  1.169265053 1.0000000
Allotments-Park                  -1.410287760 -2.9098492698  0.089273750 0.0267039
Arable-Park                      -0.433964256 -1.7267367936  0.858808282 0.9999823
Bridge-Park                      -0.196851630 -0.9580380441  0.564334785 1.0000000
Burial ground-Park               -0.836057475 -1.4547186949 -0.217396256 0.0000061
Canal-Park                        0.048244224 -0.8904260227  0.986914470 1.0000000
Coastal-Park                      0.889753377  0.0194518372  1.760054917 0.0067574
Common-Park                      -0.242860837 -1.3425524870  0.856830813 1.0000000
Country estate-Park              -0.120509395 -0.8900546800  0.649035891 1.0000000
Entrance-Park                    -1.023051793 -1.9719047406 -0.074198846 0.0024095
Event-Park                       -1.336865645 -2.7002891291  0.026557840 0.0139302
Gardens-Park                      0.133077936 -0.8157750108  1.081930884 1.0000000
Golf course-Park                 -0.423166781 -0.9175385657  0.071205004 0.0909084
Green-Park                       -0.604167430 -2.0533755912  0.845040730 0.9985160
Hill-Park                         1.216767444  0.2345425579  2.198992329 0.0000853
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Historic-Park	0.021185918	-0.7483593675	0.790731203	1.0000000
Memorial-Park	-1.041047047	-1.9515781946	-0.130515900	0.0006626
Moorland-Park	0.586171855	-0.4210228445	1.593366555	0.8500737
Park building-Park	-1.392765645	-2.3123006775	-0.473230612	0.0000001
Parkland-Park	0.466824275	-0.3115205272	1.245169077	0.8039263
Pasture-Park	-0.182031102	-0.8606571622	0.496594959	0.9999999
Path-Park	-0.088856839	-0.6393830536	0.461669375	1.0000000
Play area-Park	-1.747703145	-3.2472646544	-0.248141635	0.0004187
Playing field-Park	-1.406676315	-2.3172074628	-0.496145168	0.0000000
Recreation ground-Park	-1.131033579	-2.2907278545	0.028660696	0.0152032
Sport-Park	-1.637305131	-2.2280012410	-1.046609022	0.0000000
Track-Park	-0.313431052	-1.2069693962	0.580107293	0.9999530
Trees-Park	0.061629413	-0.8319089311	0.955167758	1.0000000
Trig Point-Park	0.162118284	-1.2870898769	1.611326445	1.0000000
Waterbody-Park	0.489824666	-0.0845103655	1.064159697	0.0947136
Watercourse-Park	0.618443431	0.0225820631	1.214304798	0.0051083
Woodland-Park	0.300518009	-0.3550729288	0.956108947	0.9925856
Nature reserve-Country park	-0.126558430	-1.4115869865	1.158470127	1.0000000
Allotments-Country park	-1.444269361	-2.9633935095	0.074854787	0.0226964
Arable-Country park	-0.467945857	-1.7833599709	0.847468257	0.9999363
Bridge-Country park	-0.230833231	-1.0298690336	0.568202572	0.9999995
Burial ground-Country park	-0.870039076	-1.5347158109	-0.205362342	0.0000169
Canal-Country park	0.014262623	-0.9553534294	0.983878675	1.0000000
Coastal-Country park	0.855771776	-0.0478200716	1.759363624	0.0240551
Common-Country park	-0.276842438	-1.4030640779	0.849379202	1.0000000
Country estate-Country park	-0.154490996	-0.9614937237	0.652511732	1.0000000

Entrance-Country park	-1.057033394	-2.0365104856	-0.077556303	0.0023647
Event-Country park	-1.370847246	-2.7557577319	0.014063240	0.0119005
Gardens-Country park	0.099096335	-0.8803807559	1.078573427	1.0000000
Golf course-Country park	-0.457148382	-1.0080176208	0.093720857	0.1269608
Green-Country park	-0.638149031	-2.1075903369	0.831292274	0.9969526
Hill-Country park	1.182785842	0.1709463380	2.194625347	0.0003892
Historic-Country park	-0.012795683	-0.8197984112	0.794207045	1.0000000
Memorial-Country park	-1.075028648	-2.0174300633	-0.132627233	0.0006990
Moorland-Country park	0.552190254	-0.4839056005	1.588286109	0.9407252
Park building-Country park	-1.426747246	-2.3778508853	-0.475643606	0.0000001
Parkland-Country park	0.432842674	-0.3825554422	1.248240789	0.9434475
Pasture-Country park	-0.216012703	-0.9368363891	0.504810984	0.9999988
Path-Country park	-0.122838440	-0.7246129574	0.478936077	1.0000000
Play area-Country park	-1.781684746	-3.3008088941	-0.262560597	0.0003586
Playing field-Country park	-1.440657916	-2.3830593316	-0.498256501	0.0000001
Recreation ground-Country park	-1.165015181	-2.3498967225	0.019866361	0.0133095
Sport-Country park	-1.671286733	-2.3100162140	-1.032557251	0.0000000
Track-Country park	-0.347412653	-1.2734062974	0.578580992	0.9998057
Trees-Country park	0.027647812	-0.8983458323	0.953641457	1.0000000
Trig Point-Country park	0.128136683	-1.3413046226	1.597577988	1.0000000
Waterbody-Country park	0.455843065	-0.1677867813	1.079472911	0.3624219
Watercourse-Country park	0.584461830	-0.0590474758	1.227971135	0.0436703
Woodland-Country park	0.266536408	-0.4326437795	0.965716596	0.9997316
Allotments-Nature reserve	-1.317710931	-3.1888101263	0.553388264	0.4511900
Arable-Nature reserve	-0.341387427	-2.0512378037	1.368462950	1.0000000
Bridge-Nature reserve	-0.104274801	-1.4576898273	1.249140226	1.0000000

Burial ground-Nature reserve	-0.743480646	-2.0221788834	0.535217590	0.8513899
Canal-Nature reserve	0.140821053	-1.3198052884	1.601447394	1.0000000
Coastal-Nature reserve	0.982330206	-0.4353271034	2.399987515	0.4907859
Common-Nature reserve	-0.150284008	-1.7192483805	1.418680364	1.0000000
Country estate-Nature reserve	-0.027932566	-1.3860663673	1.330201236	1.0000000
Entrance-Nature reserve	-0.930474964	-2.3976659513	0.536716022	0.6977504
Event-Nature reserve	-1.244288816	-3.0081626986	0.519585067	0.4470976
Gardens-Nature reserve	0.225654765	-1.2415362216	1.692845752	1.0000000
Golf course-Nature reserve	-0.330589952	-1.5539995066	0.892819602	0.9999999
Green-Nature reserve	-0.511590602	-2.3425826195	1.319401416	0.9999998
Hill-Nature reserve	1.309344272	-0.1796463933	2.798334938	0.0661658
Historic-Nature reserve	0.113762747	-1.2443710548	1.471896548	1.0000000
Memorial-Nature reserve	-0.948470218	-2.3911740849	0.494233648	0.6174576
Moorland-Nature reserve	0.678748684	-0.8268304867	2.184327855	0.9943186
Park building-Nature reserve	-1.300188816	-2.7485921274	0.148214496	0.0509865
Parkland-Nature reserve	0.559401104	-0.8037379602	1.922540167	0.9988874
Pasture-Nature reserve	-0.089454273	-1.3982173554	1.219308810	1.0000000
Path-Nature reserve	0.003719990	-1.2434394185	1.250879398	1.0000000
Play area-Nature reserve	-1.655126316	-3.5262255109	0.215972879	0.0614902
Playing field-Nature reserve	-1.314099487	-2.7568033532	0.128604380	0.0420062
Recreation ground-Nature reserve	-1.038456751	-2.6500454972	0.573131996	0.6631547
Sport-Nature reserve	-1.544728303	-2.8101331272	-0.279323478	0.0001274
Track-Nature reserve	-0.220854223	-1.6528941139	1.211185668	1.0000000
Trees-Nature reserve	0.154206242	-1.2778336488	1.586246133	1.0000000
Trig Point-Nature reserve	0.254695113	-1.5762969052	2.085687131	1.0000000
Waterbody-Nature reserve	0.582401495	-0.6754491341	1.840252124	0.9913257

Watercourse-Nature reserve	0.711020260	-0.5568039577	1.978844477	0.8958714
Woodland-Nature reserve	0.393094838	-0.9038735326	1.690063209	0.9999984
Arable-Allotments	0.976323504	-0.9157727138	2.868419722	0.9600445
Bridge-Allotments	1.213436131	-0.3639579297	2.790830191	0.2519936
Burial ground-Allotments	0.574230285	-0.9395428054	2.088003375	0.9997569
Canal-Allotments	1.458531984	-0.2117581393	3.128822107	0.0720303
Coastal-Allotments	2.300041137	0.6671933077	3.932888967	0.0000014
Common-Allotments	1.167426923	-0.5983842188	2.933238065	0.6043130
Country estate-Allotments	1.289778365	-0.2916662937	2.871223024	0.1509946
Entrance-Allotments	0.387235967	-1.2887977976	2.063269731	1.0000000
Event-Allotments	0.073422115	-1.8676319440	2.014476175	1.0000000
Gardens-Allotments	1.543365696	-0.1326680679	3.219399461	0.0361542
Golf course-Allotments	0.987120979	-0.4802476608	2.454489619	0.5628971
Green-Allotments	0.806120330	-1.1961213034	2.808361963	0.9992214
Hill-Allotments	2.627055204	0.9319053608	4.322205046	0.0000000
Historic-Allotments	1.431473678	-0.1499709812	3.012918337	0.0456970
Memorial-Allotments	0.369240713	-1.2853994999	2.023880926	1.0000000
Moorland-Allotments	1.996459615	0.2867203291	3.706198902	0.0003996
Park building-Allotments	0.017522115	-1.6420898694	1.677134100	1.0000000
Parkland-Allotments	1.877112035	0.2913668174	3.462857252	0.0002845
Pasture-Allotments	1.228256658	-0.3109966001	2.767509917	0.1851413
Path-Allotments	1.321430921	-0.1657968278	2.808658669	0.0581478
Play area-Allotments	-0.337415385	-2.3763984608	1.701567692	1.0000000
Playing field-Allotments	0.003611445	-1.6510287682	1.658251658	1.0000000
Recreation ground-Allotments	0.279254181	-1.5245357394	2.083044101	1.0000000
Sport-Allotments	-0.227017371	-1.7295782379	1.275543495	1.0000000

Track-Allotments	1.096856708	-0.5484937214	2.742207138	0.5846474
Trees-Allotments	1.471917174	-0.1734332563	3.117267603	0.0533062
Trig Point-Allotments	1.572406044	-0.4298355891	3.574647677	0.2128465
Waterbody-Allotments	1.900112426	0.4039078972	3.396316955	0.0000420
Watercourse-Allotments	2.028731191	0.5241322299	3.533330152	0.0000065
Woodland-Allotments	1.710805769	0.1815684621	3.240043076	0.0010908
Bridge-Arable	0.237112626	-1.1451855089	1.619410761	1.0000000
Burial ground-Arable	-0.402093220	-1.7113239408	0.907137502	0.9999978
Canal-Arable	0.482208480	-1.0052205804	1.969637540	0.9999920
Coastal-Arable	1.323717633	-0.1215394886	2.768974754	0.0389532
Common-Arable	0.191103419	-1.4028429737	1.785049811	1.0000000
Country estate-Arable	0.313454861	-1.0734637821	1.700373504	1.0000000
Entrance-Arable	-0.589087538	-2.0829634669	0.904788392	0.9994766
Event-Arable	-0.902901389	-2.6890332358	0.883230458	0.9693626
Gardens-Arable	0.567042192	-0.9268337372	2.060918122	0.9997538
Golf course-Arable	0.010797475	-1.2444900773	1.266085027	1.0000000
Green-Arable	-0.170203175	-2.0226468769	1.682240528	1.0000000
Hill-Arable	1.650731699	0.1354399443	3.166023454	0.0019433
Historic-Arable	0.455150174	-0.9317684696	1.842068817	0.9999894
Memorial-Arable	-0.607082791	-2.0769162334	0.862750651	0.9987475
Moorland-Arable	1.020136111	-0.5114593120	2.551731534	0.5867174
Park building-Arable	-0.958801389	-2.4342294804	0.516626703	0.6441320
Parkland-Arable	0.900788530	-0.4910318629	2.292608924	0.6533462
Pasture-Arable	0.251933154	-1.0866768365	1.590543145	1.0000000
Path-Arable	0.345107417	-0.9333379243	1.623552757	0.9999999
Play area-Arable	-1.313738889	-3.2058351069	0.578357329	0.4858273

Playing field-Arable	-0.972712060	-2.4425455016	0.497121382	0.6019779
Recreation ground-Arable	-0.697069324	-2.3329893060	0.938850659	0.9978088
Sport-Arable	-1.203340876	-2.4995913417	0.092909590	0.0322513
Track-Arable	0.120533204	-1.3388345186	1.579900927	1.0000000
Trees-Arable	0.495593669	-0.9637740534	1.954961392	0.9999770
Trig Point-Arable	0.596082540	-1.2563611626	2.448526242	0.9999933
Waterbody-Arable	0.923788922	-0.3650881496	2.212665993	0.4086942
Watercourse-Arable	1.052407686	-0.2462047061	2.351020079	0.1604683
Woodland-Arable	0.734482265	-0.5925983109	2.061562841	0.9094023
Burial ground-Bridge	-0.639205846	-1.4280207826	0.149609091	0.1606045
Canal-Bridge	0.245095853	-0.8134829731	1.303674680	1.0000000
Coastal-Bridge	1.086605007	0.0881501652	2.085059848	0.0019849
Common-Bridge	-0.046009207	-1.2496740384	1.157655623	1.0000000
Country estate-Bridge	0.076342235	-0.8356266495	0.988311119	1.0000000
Entrance-Bridge	-0.826200164	-1.8938186422	0.241418315	0.2403149
Event-Bridge	-1.140014015	-2.5886032937	0.308575263	0.2090519
Gardens-Bridge	0.329929566	-0.7376889125	1.397548044	0.9999974
Golf course-Bridge	-0.226315152	-0.9219377226	0.469307420	0.9999913
Green-Bridge	-0.407315801	-1.9369208458	1.122289244	0.9999999
Hill-Bridge	1.413619073	0.3162344432	2.511003703	0.0000275
Historic-Bridge	0.218037547	-0.6939313370	1.130006432	1.0000000
Memorial-Bridge	-0.844195418	-1.8779044049	0.189513570	0.1490367
Moorland-Bridge	0.783023485	-0.3367659879	1.902812958	0.4685201
Park building-Bridge	-1.195914015	-2.2375626970	-0.154265333	0.0006009
Parkland-Bridge	0.663675904	-0.2557303882	1.583082197	0.3917668
Pasture-Bridge	0.014820528	-0.8218518273	0.851492883	1.0000000

Path-Bridge	0.107994790	-0.6285962853	0.844585866	1.0000000
Play area-Bridge	-1.550851515	-3.1282455754	0.026542545	0.0133230
Playing field-Bridge	-1.209824686	-2.2435336732	-0.176115699	0.0003777
Recreation ground-Bridge	-0.934181950	-2.1929027735	0.324538874	0.3277711
Sport-Bridge	-1.440453502	-2.2075318511	-0.673375153	0.0000000
Track-Bridge	-0.116579422	-1.1353522492	0.902193405	1.0000000
Trees-Bridge	0.258481043	-0.7602917840	1.277253870	1.0000000
Trig Point-Bridge	0.358969913	-1.1706351315	1.888574958	1.0000000
Waterbody-Bridge	0.686676295	-0.0678752457	1.441227837	0.0425172
Watercourse-Bridge	0.815295060	0.0442321125	1.586358008	0.0035699
Woodland-Bridge	0.497369639	-0.3207298528	1.315469130	0.7804928
Canal-Burial ground	0.884301699	-0.0769090365	1.845512435	0.0366267
Coastal-Burial ground	1.725810852	0.8312444675	2.620377237	0.0000000
Common-Burial ground	0.593196638	-0.5257966466	1.712189923	0.9443521
Country estate-Burial ground	0.715548081	-0.0813359716	1.512432133	0.0507931
Entrance-Burial ground	-0.186994318	-1.1581514433	0.784162807	1.0000000
Event-Burial ground	-0.500808169	-1.8798469086	0.878230570	0.9999012
Gardens-Burial ground	0.969135412	-0.0020217136	1.940292537	0.0103653
Golf course-Burial ground	0.412890694	-0.1230455968	0.948826985	0.2490600
Green-Burial ground	0.231890045	-1.2320186066	1.695798697	1.0000000
Hill-Burial ground	2.052824919	1.0490371063	3.056612732	0.0000000
Historic-Burial ground	0.857243393	0.0603593409	1.654127446	0.0025250
Memorial-Burial ground	-0.204989572	-1.1387407255	0.728761582	1.0000000
Moorland-Burial ground	1.422229331	0.3939952085	2.450463453	0.0000028
Park building-Burial ground	-0.556708169	-1.4992414171	0.385825079	0.8284213
Parkland-Burial ground	1.302881750	0.4974968251	2.108266675	0.0000000

Pasture-Burial ground	0.654026374	-0.0554506003	1.363503348	0.0356101
Path-Burial ground	0.747200636	0.1590651421	1.335336130	0.0000415
Play area-Burial ground	-0.911645669	-2.4254187594	0.602127421	0.7970013
Playing field-Burial ground	-0.570618840	-1.5043699938	0.363132314	0.7711576
Recreation ground-Burial ground	-0.294976104	-1.4729892867	0.883037079	1.0000000
Sport-Burial ground	-0.801247656	-1.4271439258	-0.175351386	0.0000332
Track-Burial ground	0.522626424	-0.3945622264	1.439815074	0.8776581
Trees-Burial ground	0.897686889	-0.0195017613	1.814875539	0.0143526
Trig Point-Burial ground	0.998175759	-0.4657328923	2.462084411	0.5301576
Waterbody-Burial ground	1.325882141	0.7154028419	1.936361441	0.0000000
Watercourse-Burial ground	1.454500906	0.8237275584	2.085274254	0.0000000
Woodland-Burial ground	1.136575485	0.4490991397	1.824051829	0.0000000
Coastal-Canal	0.841509153	-0.2980561779	1.981074485	0.3390662
Common-Canal	-0.291105061	-1.6141719899	1.031961868	1.0000000
Country estate-Canal	-0.168753618	-1.2333588598	0.895851623	1.0000000
Entrance-Canal	-1.071296017	-2.2719234736	0.129331439	0.0551071
Event-Canal	-1.385109868	-2.9343380542	0.164118317	0.0537126
Gardens-Canal	0.084833713	-1.1157937438	1.285461169	1.0000000
Golf course-Canal	-0.471411005	-1.3577449347	0.414922925	0.9421342
Green-Canal	-0.652411654	-2.2776466117	0.972823303	0.9992636
Hill-Canal	1.168523220	-0.0586483655	2.395694805	0.0221638
Historic-Canal	-0.027058306	-1.0916635473	1.037546935	1.0000000
Memorial-Canal	-1.089291271	-2.2598686260	0.081286084	0.0311598
Moorland-Canal	0.537927632	-0.7093195521	1.785174815	0.9972939
Park building-Canal	-1.441009868	-2.6186044720	-0.263415265	0.0001194
Parkland-Canal	0.418580051	-0.6524031443	1.489563246	0.9995599

Pasture-Canal	-0.230275325	-1.2311338088	0.770583158	1.0000000
Path-Canal	-0.137101063	-1.0559391807	0.781737055	1.0000000
Play area-Canal	-1.795947368	-3.4662374915	-0.125657245	0.0025498
Playing field-Canal	-1.454920539	-2.6254978943	-0.284343184	0.0000777
Recreation ground-Canal	-1.179277803	-2.5526223286	0.194066722	0.0876852
Sport-Canal	-1.685549355	-2.6290037884	-0.742094922	0.0000000
Track-Canal	-0.361675275	-1.5190840826	0.795733532	0.9999966
Trees-Canal	0.013385190	-1.1440236175	1.170793997	1.0000000
Trig Point-Canal	0.113874060	-1.5113608974	1.739109018	1.0000000
Waterbody-Canal	0.441580442	-0.4917175285	1.374878413	0.9879375
Watercourse-Canal	0.570199207	-0.3764977579	1.516896172	0.7968038
Woodland-Canal	0.252273785	-0.7331113432	1.237658914	1.0000000
Common-Coastal	-1.132614214	-2.4080862983	0.142857870	0.0585822
Country estate-Coastal	-1.010262772	-2.0151046790	-0.005420864	0.0091075
Entrance-Coastal	-1.912805170	-3.0607726037	-0.764837737	0.0000000
Event-Coastal	-2.226619022	-3.7354036022	-0.717834441	0.0000002
Gardens-Coastal	-0.756675441	-1.9046428740	0.391291993	0.6113652
Golf course-Coastal	-1.312920158	-2.1264991487	-0.499341168	0.0000000
Green-Coastal	-1.493920807	-3.0806506540	0.092809039	0.0262697
Hill-Coastal	0.327014066	-0.8486870173	1.502715150	0.9999998
Historic-Coastal	-0.868567459	-1.8734093665	0.136274448	0.0812477
Memorial-Coastal	-1.930800424	-3.0473013346	-0.814299514	0.0000000
Moorland-Coastal	-0.303581522	-1.5002220174	0.893058974	1.0000000
Park building-Coastal	-2.282519022	-3.4063748795	-1.158663164	0.0000000
Parkland-Coastal	-0.422929102	-1.4345258318	0.588667627	0.9984379
Pasture-Coastal	-1.071784479	-2.0088227077	-0.134746250	0.0006564

Path-Coastal	-0.978610216	-1.8274838377	-0.129736595	0.0005449
Play area-Coastal	-2.637456522	-4.2703043511	-1.004608692	0.0000000
Playing field-Coastal	-2.296429692	-3.4129306029	-1.179928782	0.0000000
Recreation ground-Coastal	-2.020786957	-3.3483403920	-0.693233521	0.0000001
Sport-Coastal	-2.527058508	-3.4025179343	-1.651599083	0.0000000
Track-Coastal	-1.203184429	-2.3058711864	-0.100497671	0.0018782
Trees-Coastal	-0.828123964	-1.9308107213	0.274562794	0.3017703
Trig Point-Coastal	-0.727635093	-2.3143649397	0.859094753	0.9925389
Waterbody-Coastal	-0.399928711	-1.2644332170	0.464575795	0.9914422
Watercourse-Coastal	-0.271309946	-1.1502627789	0.607642886	0.9999975
Woodland-Coastal	-0.589235368	-1.5097280569	0.331257321	0.6776879
Country estate-Common	0.122351442	-1.0866168011	1.331319686	1.0000000
Entrance-Common	-0.780190956	-2.1105015151	0.550119602	0.8390647
Event-Common	-1.094004808	-2.7457698834	0.557760268	0.6000516
Gardens-Common	0.375938773	-0.9543717854	1.706249332	0.9999997
Golf course-Common	-0.180305944	-1.2356768404	0.875064952	1.0000000
Green-Common	-0.361306593	-2.0845618156	1.361948629	1.0000000
Hill-Common	1.459628281	0.1053129578	2.813943603	0.0024297
Historic-Common	0.264046755	-0.9449214886	1.473014998	1.0000000
Memorial-Common	-0.798186210	-2.1014403058	0.505067886	0.7670901
Moorland-Common	0.829032692	-0.5434997957	2.201565180	0.7919261
Park building-Common	-1.149904808	-2.4594653996	0.159655784	0.0673427
Parkland-Common	0.709685112	-0.5049032540	1.924273477	0.8444474
Pasture-Common	0.060829735	-1.0923994689	1.214058940	1.0000000
Path-Common	0.154003998	-0.9288087193	1.236816715	1.0000000
Play area-Common	-1.504842308	-3.2706534496	0.260968834	0.0955180

Playing field-Common	-1.163815478	-2.4670695741	0.139438617	0.0545351
Recreation ground-Common	-0.888172742	-2.3762235074	0.599878022	0.8118934
Sport-Common	-1.394444294	-2.4982224249	-0.290666164	0.0000489
Track-Common	-0.070570215	-1.3620093501	1.220868921	1.0000000
Trees-Common	0.304490250	-0.9869488850	1.595929386	1.0000000
Trig Point-Common	0.404979121	-1.3182761013	2.128234343	1.0000000
Waterbody-Common	0.732685503	-0.3624240786	1.827795085	0.5760176
Watercourse-Common	0.861304268	-0.2452466967	1.967855232	0.2292618
Woodland-Common	0.543378846	-0.5964473447	1.683205037	0.9865071
Entrance-Country estate	-0.902542399	-1.9761365509	0.171051754	0.1108624
Event-Country estate	-1.216356250	-2.6693552473	0.236642747	0.1159451
Gardens-Country estate	0.253587331	-0.8200068212	1.327181483	1.0000000
Golf course-Country estate	-0.302657386	-1.0074168842	0.402102111	0.9974877
Green-Country estate	-0.483658036	-2.0174398917	1.050123820	0.9999958
Hill-Country estate	1.337276838	0.2340777563	2.440475920	0.0001538
Historic-Country estate	0.141695313	-0.7772619414	1.060652566	1.0000000
Memorial-Country estate	-0.920537652	-1.9604171930	0.119341888	0.0609195
Moorland-Country estate	0.706681250	-0.4188069337	1.832169434	0.7185547
Park building-Country estate	-1.272256250	-2.3200287276	-0.224483772	0.0001470
Parkland-Country estate	0.587333669	-0.3390048859	1.513672225	0.6982523
Pasture-Country estate	-0.061521707	-0.9058059117	0.782762498	1.0000000
Path-Country estate	0.031652555	-0.7135733171	0.776878428	1.0000000
Play area-Country estate	-1.627193750	-3.2086384091	-0.045749091	0.0060073
Playing field-Country estate	-1.286166921	-2.3260464613	-0.246287380	0.0000891
Recreation ground-Country estate	-1.010524185	-2.2743174036	0.253269034	0.1817437
Sport-Country estate	-1.516795737	-2.2921694416	-0.741422032	0.0000000

Track-Country estate	-0.192921657	-1.2179549547	0.832111641	1.0000000
Trees-Country estate	0.182138808	-0.8428944896	1.207172106	1.0000000
Trig Point-Country estate	0.282627679	-1.2511541774	1.816409535	1.0000000
Waterbody-Country estate	0.610334061	-0.1526490431	1.373317164	0.1810550
Watercourse-Country estate	0.738952825	-0.0403630655	1.518268716	0.0236268
Woodland-Country estate	0.421027404	-0.4048551340	1.246909942	0.9657846
Event-Entrance	-0.313813851	-1.8692327838	1.241605081	1.0000000
Gardens-Entrance	1.156129730	-0.0524754056	2.364734865	0.0206580
Golf course-Entrance	0.599885012	-0.2972258611	1.496995886	0.5773304
Green-Entrance	0.418884363	-1.2122528940	2.050021620	1.0000000
Hill-Entrance	2.239819237	1.0048414299	3.474797044	0.0000000
Historic-Entrance	1.044237711	-0.0293564411	2.117831863	0.0158817
Memorial-Entrance	-0.017995254	-1.1967536803	1.160763173	1.0000000
Moorland-Entrance	1.609223649	0.3542951164	2.864152181	0.0000315
Park building-Entrance	-0.369713851	-1.5554411110	0.816013408	0.9999968
Parkland-Entrance	1.489876068	0.4099570487	2.569795087	0.0000030
Pasture-Entrance	0.841020692	-0.1693939696	1.851435353	0.1231060
Path-Entrance	0.934194954	0.0049567874	1.863433121	0.0091171
Play area-Entrance	-0.724651351	-2.4006851157	0.951382413	0.9971758
Playing field-Entrance	-0.383624522	-1.5623829486	0.795133904	0.9999913
Recreation ground-Entrance	-0.107981786	-1.4883061210	1.272342549	1.0000000
Sport-Entrance	-0.614253338	-1.5678393864	0.339332710	0.6639044
Track-Entrance	0.709620742	-0.4560615610	1.875303044	0.7781287
Trees-Entrance	1.084681207	-0.0810010959	2.250363509	0.0311824
Trig Point-Entrance	1.185170077	-0.4459671798	2.816307334	0.3763540
Waterbody-Entrance	1.512876459	0.5693378083	2.456415110	0.0000000

Watercourse-Entrance	1.641495224	0.6847009791	2.598289469	0.0000000
Woodland-Entrance	1.323569802	0.3284798891	2.318659716	0.0000102
Gardens-Event	1.469943581	-0.0854753514	3.025362514	0.0248427
Golf course-Event	0.913698864	-0.4142354726	2.241633200	0.5080324
Green-Event	0.732698214	-1.1697240400	2.635120469	0.9996706
Hill-Event	2.553633088	0.9776343997	4.129631777	0.0000000
Historic-Event	1.358051563	-0.0949474348	2.811050560	0.0292439
Memorial-Event	0.295818598	-1.2365237632	1.828160958	1.0000000
Moorland-Event	1.923037500	0.3313568463	3.514718154	0.0001678
Park building-Event	-0.055900000	-1.5936096009	1.481809601	1.0000000
Parkland-Event	1.803689919	0.3460113640	3.261368475	0.0000880
Pasture-Event	1.154834543	-0.2521265332	2.561795619	0.1418291
Path-Event	1.248008805	-0.1018375757	2.597855187	0.0341683
Play area-Event	-0.410837500	-2.3518915594	1.530216559	1.0000000
Playing field-Event	-0.069810671	-1.6021530315	1.462531690	1.0000000
Recreation ground-Event	0.205832065	-1.4864731530	1.898137283	1.0000000
Sport-Event	-0.300439487	-1.6671611241	1.066282151	1.0000000
Track-Event	1.023434593	-0.4988718522	2.545741038	0.5644127
Trees-Event	1.398495058	-0.1238113871	2.920801503	0.0373645
Trig Point-Event	1.498983929	-0.4034383257	3.401406183	0.2068959
Waterbody-Event	1.826690311	0.4669598710	3.186420750	0.0000074
Watercourse-Event	1.955309075	0.5863470929	3.324271058	0.0000009
Woodland-Event	1.637383654	0.2413873723	3.033379935	0.0003580
Golf course-Gardens	-0.556244717	-1.4533555908	0.340866156	0.7437061
Green-Gardens	-0.737245367	-2.3683826238	0.893891890	0.9940776
Hill-Gardens	1.083689507	-0.1512882998	2.318667314	0.0678948

Historic-Gardens	-0.111892019	-1.1854861709	0.961702134	1.0000000
Memorial-Gardens	-1.174124984	-2.3528834101	0.004633443	0.0107000
Moorland-Gardens	0.453093919	-0.8018346133	1.708022451	0.9999126
Park building-Gardens	-1.525843581	-2.7115708407	-0.340116321	0.0000284
Parkland-Gardens	0.333746338	-0.7461726810	1.413665358	0.9999974
Pasture-Gardens	-0.315109038	-1.3255236993	0.695305623	0.9999968
Path-Gardens	-0.221934776	-1.1511729423	0.707303391	1.0000000
Play area-Gardens	-1.880781081	-3.5568148454	-0.204747317	0.0010184
Playing field-Gardens	-1.539754252	-2.7185126783	-0.360995825	0.0000180
Recreation ground-Gardens	-1.264111516	-2.6444358507	0.116212819	0.0390100
Sport-Gardens	-1.770383068	-2.7239691161	-0.816797020	0.0000000
Track-Gardens	-0.446508988	-1.6121912908	0.719173315	0.9997045
Trees-Gardens	-0.071448523	-1.2371308257	1.094233780	1.0000000
Trig Point-Gardens	0.029040347	-1.6020969095	1.660177604	1.0000000
Waterbody-Gardens	0.356746730	-0.5867919215	1.300285381	0.9997726
Watercourse-Gardens	0.485365494	-0.4714287506	1.442159739	0.9679157
Woodland-Gardens	0.167440073	-0.8276498406	1.162529986	1.0000000
Green-Golf course	-0.181000649	-1.5968715111	1.234870212	1.0000000
Hill-Golf course	1.639934225	0.7075975206	2.572270929	0.0000000
Historic-Golf course	0.444352699	-0.2604067990	1.149112197	0.7099840
Memorial-Golf course	-0.617880266	-1.4743573376	0.238596805	0.3931854
Moorland-Golf course	1.009338636	0.0507317477	1.967945525	0.0038771
Park building-Golf course	-0.969598864	-1.8356419804	-0.103555747	0.0010726
Parkland-Golf course	0.889991056	0.1756335583	1.604348553	0.0000727
Pasture-Golf course	0.241135679	-0.3630326197	0.845303978	0.9993401
Path-Golf course	0.334309942	-0.1212832060	0.789903090	0.3534845

Play area-Golf course	-1.324536364	-2.7919050034	0.142832276	0.0474105
Playing field-Golf course	-0.983509534	-1.8399866059	-0.127032463	0.0005981
Recreation ground-Golf course	-0.707866798	-1.8256220557	0.409888459	0.7007363
Sport-Golf course	-1.214138350	-1.7175347126	-0.710741988	0.0000000
Track-Golf course	0.109735729	-0.7286536651	0.948125124	1.0000000
Trees-Golf course	0.484796195	-0.3535932000	1.323185589	0.8589004
Trig Point-Golf course	0.585285065	-0.8305857968	2.001155927	0.9987282
Waterbody-Golf course	0.912991447	0.4288977247	1.397085169	0.0000000
Watercourse-Golf course	1.041610212	0.5321626943	1.551057729	0.0000000
Woodland-Golf course	0.723684790	0.1455105244	1.301859056	0.0000638
Hill-Green	1.820934874	0.1701615516	3.471708196	0.0014876
Historic-Green	0.625353348	-0.9084285078	2.159135204	0.9990136
Memorial-Green	-0.436879617	-2.0460265355	1.172267302	0.9999999
Moorland-Green	1.190339286	-0.4754121961	2.856090767	0.4158753
Park building-Green	-0.788598214	-2.4028570263	0.825660598	0.9807932
Parkland-Green	1.070991705	-0.4672239710	2.609207381	0.4790474
Pasture-Green	0.422136329	-1.0681053180	1.912377975	0.9999997
Path-Green	0.515310591	-0.9211315234	1.951752706	0.9999238
Play area-Green	-1.143535714	-3.1457773473	0.858705919	0.8748414
Playing field-Green	-0.802508885	-2.4116558038	0.806638034	0.9744348
Recreation ground-Green	-0.526866149	-2.2890175748	1.235285277	0.9999988
Sport-Green	-1.033137701	-2.4854492136	0.419173812	0.4267565
Track-Green	0.290736379	-1.3088565722	1.890329330	1.0000000
Trees-Green	0.665796844	-0.9337961071	2.265389795	0.9985584
Trig Point-Green	0.766285714	-1.1985275412	2.731098970	0.9995779
Waterbody-Green	1.093992096	-0.3517421683	2.539726361	0.2856544

Watercourse-Green	1.222610861	-0.2318091625	2.677030885	0.1109418
Woodland-Green	0.904685440	-0.5752085815	2.384579461	0.7705163
Historic-Hill	-1.195581526	-2.2987806077	-0.092382444	0.0021667
Memorial-Hill	-2.257814491	-3.4635985670	-1.052030414	0.0000000
Moorland-Hill	-0.630595588	-1.9109429753	0.649751799	0.9784693
Park building-Hill	-2.609533088	-3.8221306904	-1.396935486	0.0000000
Parkland-Hill	-0.749943169	-1.8592983414	0.359412004	0.5510632
Pasture-Hill	-1.398798545	-2.4406150350	-0.356982055	0.0000075
Path-Hill	-1.305624283	-2.2689141566	-0.342334409	0.0000055
Play area-Hill	-2.964470588	-4.6596204311	-1.269320745	0.0000000
Playing field-Hill	-2.623443759	-3.8292278353	-1.417659683	0.0000000
Recreation ground-Hill	-2.347801023	-3.7512749558	-0.944327090	0.0000000
Sport-Hill	-2.854072575	-3.8408705088	-1.867274641	0.0000000
Track-Hill	-1.530198495	-2.7232027037	-0.337194287	0.0000313
Trees-Hill	-1.155138030	-2.3481422386	0.037866178	0.0170773
Trig Point-Hill	-1.054649160	-2.7054224820	0.596124163	0.6819354
Waterbody-Hill	-0.726942778	-1.7040348902	0.250149335	0.3223249
Watercourse-Hill	-0.598324013	-1.5882225115	0.391574486	0.7907421
Woodland-Hill	-0.916249434	-1.9432098748	0.110711006	0.0551740
Memorial-Historic	-1.062232965	-2.1021125055	-0.022353424	0.0068609
Moorland-Historic	0.564985938	-0.5605022462	1.690474121	0.9720770
Park building-Historic	-1.413951562	-2.4617240401	-0.366179085	0.0000063
Parkland-Historic	0.445638357	-0.4807001984	1.371976912	0.9845855
Pasture-Historic	-0.203217019	-1.0475012242	0.641067185	1.0000000
Path-Historic	-0.110042757	-0.8552686296	0.635183115	1.0000000
Play area-Historic	-1.768889063	-3.3503337216	-0.187444403	0.0010953

Playing field-Historic	-1.427862233	-2.4677417738	-0.387982693	0.0000035
Recreation ground-Historic	-1.152219497	-2.4160127161	0.111573722	0.0414738
Sport-Historic	-1.658491049	-2.4338647541	-0.883117344	0.0000000
Track-Historic	-0.334616969	-1.3596502672	0.690416328	0.9999906
Trees-Historic	0.040443496	-0.9845898021	1.065476793	1.0000000
Trig Point-Historic	0.140932366	-1.3928494899	1.674714222	1.0000000
Waterbody-Historic	0.468638748	-0.2943443556	1.231621852	0.7617411
Watercourse-Historic	0.597257513	-0.1820583780	1.376573404	0.2594767
Woodland-Historic	0.279332091	-0.5465504465	1.105214629	0.9999790
Moorland-Memorial	1.627218902	0.4010090199	2.853428785	0.0000109
Park building-Memorial	-0.351718598	-1.5070082535	0.803571058	0.9999982
Parkland-Memorial	1.507871322	0.4614631112	2.554279532	0.0000006
Pasture-Memorial	0.859015945	-0.1155007772	1.833532668	0.0642256
Path-Memorial	0.952190208	0.0621179494	1.842262466	0.0028272
Play area-Memorial	-0.706656098	-2.3612963105	0.947984115	0.9977193
Playing field-Memorial	-0.365629268	-1.5137653591	0.782506823	0.9999947
Recreation ground-Memorial	-0.089986532	-1.4442539817	1.264280917	1.0000000
Sport-Memorial	-0.596258084	-1.5117204847	0.319204316	0.6389777
Track-Memorial	0.727615995	-0.4070911411	1.862323132	0.6739106
Trees-Memorial	1.102676461	-0.0320306760	2.237383597	0.0161159
Trig Point-Memorial	1.203165331	-0.4059815877	2.812312250	0.3113439
Waterbody-Memorial	1.530871713	0.6258798673	2.435863559	0.0000000
Watercourse-Memorial	1.659490478	0.7406867545	2.578294201	0.0000000
Woodland-Memorial	1.341565056	0.3829467847	2.300183328	0.0000018
Park building-Moorland	-1.978937500	-3.2118480329	-0.746026967	0.0000000
Parkland-Moorland	-0.119347581	-1.2508705968	1.012175436	1.0000000

Pasture-Moorland	-0.768202957	-1.8335935124	0.297187598	0.3943947
Path-Moorland	-0.675028695	-1.6637666873	0.313709298	0.5270807
Play area-Moorland	-2.333875000	-4.0436142863	-0.624135714	0.0000043
Playing field-Moorland	-1.992848171	-3.2190580533	-0.766638288	0.0000000
Recreation ground-Moorland	-1.717205435	-3.1382664881	-0.296144381	0.0001671
Sport-Moorland	-2.223476987	-3.2351318683	-1.211822105	0.0000000
Track-Moorland	-0.899602907	-2.1132480276	0.314042214	0.3305673
Trees-Moorland	-0.524542442	-1.7381875625	0.689102679	0.9971934
Trig Point-Moorland	-0.424053571	-2.0898050532	1.241697910	1.0000000
Waterbody-Moorland	-0.096347189	-1.0985370087	0.905842630	1.0000000
Watercourse-Moorland	0.032271575	-0.9824079184	1.046951069	1.0000000
Woodland-Moorland	-0.285653846	-1.3365216702	0.765213978	0.9999999
Parkland-Park building	1.859589919	0.8053376491	2.913842190	0.0000000
Pasture-Park building	1.210734543	0.2277998815	2.193669204	0.0000998
Path-Park building	1.303908805	0.4046277974	2.203189813	0.0000005
Play area-Park building	-0.354937500	-2.0145494848	1.304674485	1.0000000
Playing field-Park building	-0.013910671	-1.1692003267	1.141378985	1.0000000
Recreation ground-Park building	0.261732065	-1.0986054041	1.622069535	1.0000000
Sport-Park building	-0.244539487	-1.1689577430	0.679878770	0.9999999
Track-Park building	1.079334593	-0.0626102357	2.221279422	0.0247934
Trees-Park building	1.454395058	0.3124502294	2.596339887	0.0000386
Trig Point-Park building	1.554883929	-0.0593748834	3.169142741	0.0185481
Waterbody-Park building	1.882590311	0.9685400128	2.796640609	0.0000000
Watercourse-Park building	2.011209075	1.0834817512	2.938936400	0.0000000
Woodland-Park building	1.693283654	0.7261090591	2.660458249	0.0000000
Pasture-Parkland	-0.648855376	-1.5011678207	0.203457068	0.2730676

Path-Parkland	-0.555681114	-1.3099902584	0.198628031	0.3445163
Play area-Parkland	-2.214527419	-3.8002726367	-0.628782202	0.0000020
Playing field-Parkland	-1.873500590	-2.9199088007	-0.827092379	0.0000000
Recreation ground-Parkland	-1.597857854	-2.8670284433	-0.328687265	0.0000540
Sport-Parkland	-2.104129406	-2.8882372218	-1.320021590	0.0000000
Track-Parkland	-0.780255326	-1.8119112505	0.251400598	0.2867406
Trees-Parkland	-0.405194861	-1.4368507854	0.626461063	0.9995157
Trig Point-Parkland	-0.304705991	-1.8429216669	1.233509685	1.0000000
Waterbody-Parkland	0.023000391	-0.7488570444	0.794857827	1.0000000
Watercourse-Parkland	0.151619156	-0.6363871524	0.939625464	1.0000000
Woodland-Parkland	-0.166306266	-1.0003941810	0.667781650	1.0000000
Path-Pasture	0.093174262	-0.5577443077	0.744092832	1.0000000
Play area-Pasture	-1.565672043	-3.1049253015	-0.026418785	0.0074089
Playing field-Pasture	-1.224645214	-2.1991619364	-0.250128491	0.0000569
Recreation ground-Pasture	-0.949002478	-2.1595836126	0.261578657	0.2160839
Sport-Pasture	-1.455274030	-2.1405022881	-0.770045771	0.0000000
Track-Pasture	-0.131399950	-1.0900587242	0.827258824	1.0000000
Trees-Pasture	0.243660515	-0.7149982591	1.202319289	1.0000000
Trig Point-Pasture	0.344149386	-1.1460922612	1.834391032	1.0000000
Waterbody-Pasture	0.671855768	0.0006802313	1.343031304	0.0098265
Watercourse-Pasture	0.800474532	0.1107886317	1.490160433	0.0004633
Woodland-Pasture	0.482549111	-0.2593507141	1.224448936	0.6421135
Play area-Path	-1.658846305	-3.1460740541	-0.171618557	0.0011659
Playing field-Path	-1.317819476	-2.2078917346	-0.427747218	0.0000002
Recreation ground-Path	-1.042176740	-2.1858779540	0.101524474	0.0417737
Sport-Path	-1.548448292	-2.1070926770	-0.989803907	0.0000000

Track-Path	-0.224574212	-1.0972553844	0.648106960	1.0000000
Trees-Path	0.150486253	-0.7221949193	1.023167425	1.0000000
Trig Point-Path	0.250975123	-1.1854669913	1.687417238	1.0000000
Waterbody-Path	0.578681505	0.0373660859	1.119996925	0.0028682
Watercourse-Path	0.707300270	0.1431970664	1.271403473	0.0000607
Woodland-Path	0.389374848	-0.2374912719	1.016240969	0.7402207
Playing field-Play area	0.341026829	-1.3136133836	1.995667042	1.0000000
Recreation ground-Play area	0.616669565	-1.1871203547	2.420459485	0.9999733
Sport-Play area	0.110398013	-1.3921628532	1.612958880	1.0000000
Track-Play area	1.434272093	-0.2110783368	3.079622523	0.0735386
Trees-Play area	1.809332558	0.1639821283	3.454682988	0.0015907
Trig Point-Play area	1.909821429	-0.0924202045	3.912063062	0.0215903
Waterbody-Play area	2.237527811	0.7413232818	3.733732339	0.0000001
Watercourse-Play area	2.366146575	0.8615476145	3.870745536	0.0000000
Woodland-Play area	2.048221154	0.5189838467	3.577458461	0.0000081
Recreation ground-Playing field	0.275642736	-1.0786247134	1.629910185	1.0000000
Sport-Playing field	-0.230628816	-1.1460912164	0.684833584	1.0000000
Track-Playing field	1.093245264	-0.0414618728	2.227952400	0.0184750
Trees-Playing field	1.468305729	0.3335985923	2.603012865	0.0000240
Trig Point-Playing field	1.568794599	-0.0403523194	3.177941518	0.0152952
Waterbody-Playing field	1.896500981	0.9915091356	2.801492827	0.0000000
Watercourse-Playing field	2.025119746	1.1063160228	2.943923469	0.0000000
Woodland-Playing field	1.707194325	0.7485760530	2.665812596	0.0000000
Sport-Recreation ground	-0.506271552	-1.6698415961	0.657298492	0.9968524
Track-Recreation ground	0.817602528	-0.5252988561	2.160503912	0.7779133
Trees-Recreation ground	1.192662993	-0.1502383910	2.535564377	0.0584757

Trig Point-Recreation ground	1.293151863	-0.4689995624	3.055303289	0.3533038
Waterbody-Recreation ground	1.620858245	0.4655080465	2.776208444	0.0000017
Watercourse-Recreation ground	1.749477010	0.5832762885	2.915677732	0.0000001
Woodland-Recreation ground	1.431551589	0.2337315555	2.629371622	0.0002228
Track-Sport	1.323874080	0.4253112221	2.222436937	0.0000003
Trees-Sport	1.698934545	0.8003716872	2.597497403	0.0000000
Trig Point-Sport	1.799423415	0.3471119028	3.251734928	0.0000848
Waterbody-Sport	2.127129797	1.5450085348	2.709251060	0.0000000
Watercourse-Sport	2.255748562	1.6523786877	2.859118437	0.0000000
Woodland-Sport	1.937823141	1.2754003798	2.600245901	0.0000000
Trees-Track	0.375060465	-0.7460568742	1.496177804	0.9999836
Trig Point-Track	0.475549336	-1.1240436154	2.075142287	0.9999990
Waterbody-Track	0.803255718	-0.0846373186	1.691148754	0.0460290
Watercourse-Track	0.931874482	0.0299076954	1.833841269	0.0055665
Woodland-Track	0.613949061	-0.3285438003	1.556441922	0.6386597
Trig Point-Trees	0.100488870	-1.4991040805	1.700081821	1.0000000
Waterbody-Trees	0.428195253	-0.4596977837	1.316088289	0.9840260
Watercourse-Trees	0.556814017	-0.3451527697	1.458780804	0.7521620
Woodland-Trees	0.238888596	-0.7036042655	1.181381457	1.0000000
Waterbody-Trig Point	0.327706382	-1.1180278826	1.773440647	1.0000000
Watercourse-Trig Point	0.456325147	-0.9980948768	1.910745170	0.9999963
Woodland-Trig Point	0.138399725	-1.3414942958	1.618293746	1.0000000
Watercourse-Waterbody	0.128618765	-0.4587431679	0.715980697	1.0000000
Woodland-Waterbody	-0.189306657	-0.8371822224	0.458568909	0.9999993
Woodland-Watercourse	-0.317925421	-0.9849582464	0.349107403	0.9865465

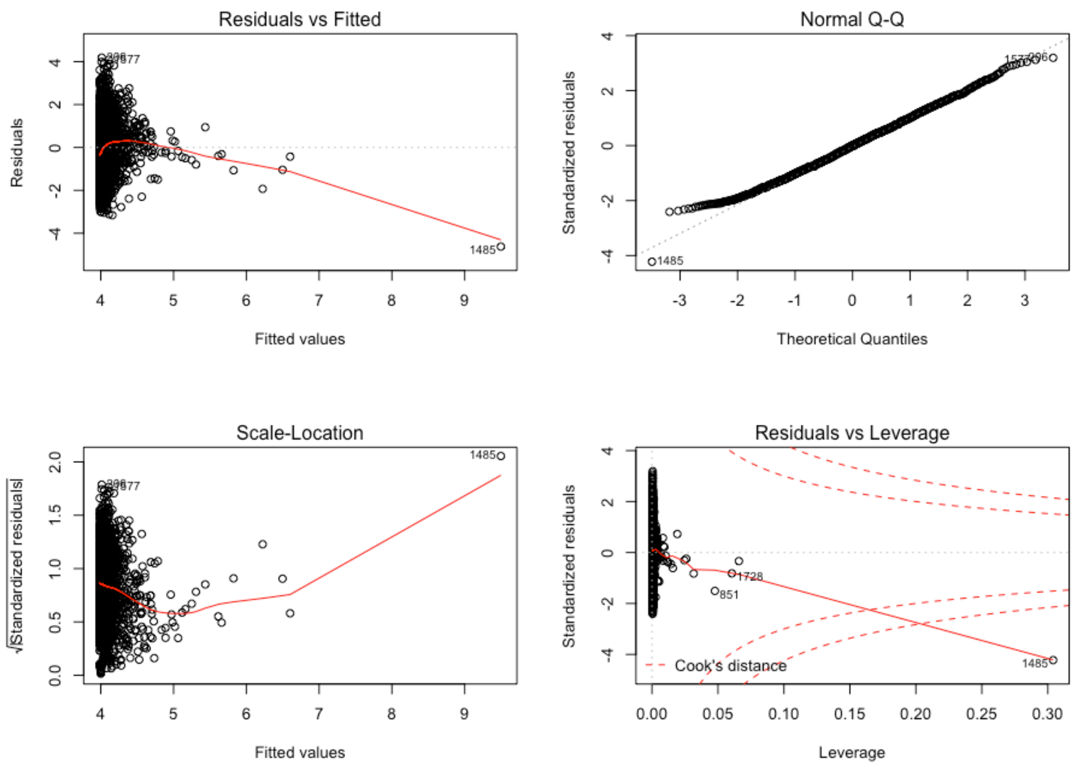
Appendix 2.4: Linear models of park area and scenicness

```
lm(formula = GeomScore$meanAverag ~ GeomScore$KM2)

Residuals:
    Min      1Q  Median      3Q     Max 
-4.6228 -0.9862 -0.0007  0.8721  4.1871 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept)    3.98545    0.03233 123.257  < 2e-16 ***
GeomScore$KM2  0.19398    0.02594   7.477 1.12e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 
' ' 1

Residual standard error: 1.312 on 2056 degrees of freedom
Multiple R-squared:  0.02647, Adjusted R-squared:  0.026 
F-statistic: 55.91 on 1 and 2056 DF,  p-value: 1.119e-13
```



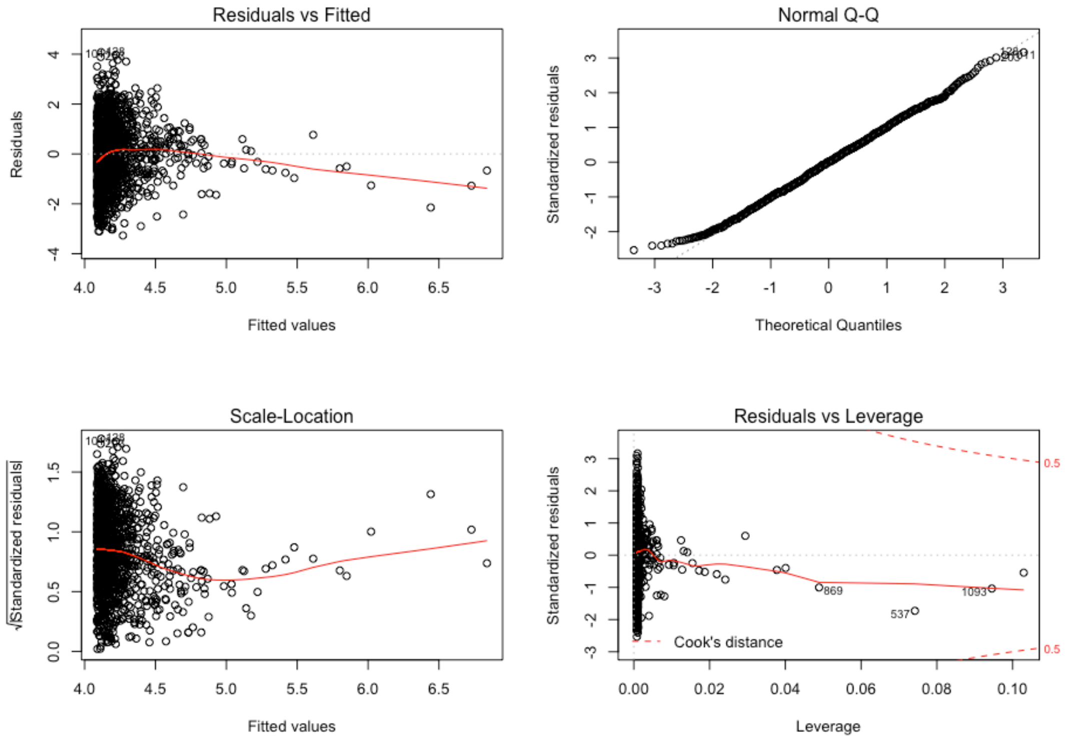
```
Outlier removed:

lm(formula = GeomScoreNO$meanAverag ~ GeomScoreNO$KM2)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.2702 -0.9347  0.0149  0.8712  4.0835 

Coefficients:
                Estimate Std. Error t value Pr(>|t|)    
(Intercept)      4.08766    0.04269  95.755  < 2e-16 ***
GeomScoreNO$KM2  0.20398    0.03229   6.318 3.66e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 
' ' 1

Residual standard error: 1.291 on 1279 degrees of freedom
Multiple R-squared:  0.03026, Adjusted R-squared:  0.0295 
F-statistic: 39.91 on 1 and 1279 DF,  p-value: 3.656e-10
```



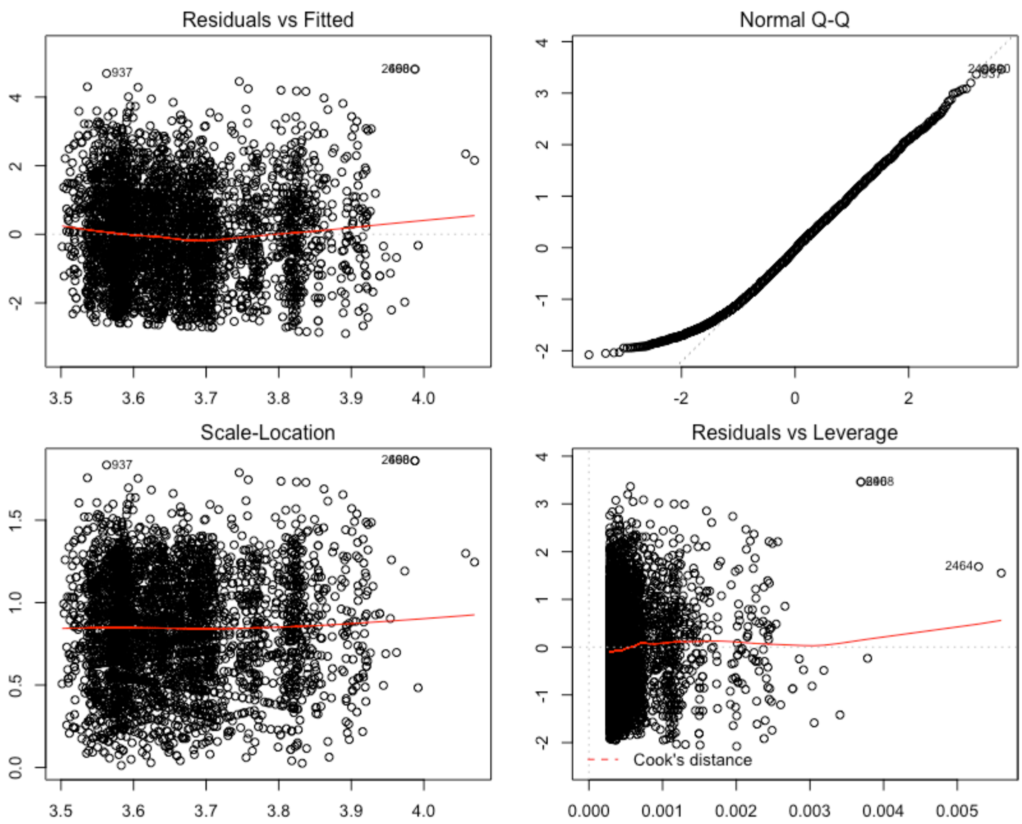
Appendix 2.5: Linear models of greenspace location and scenicness

```
Latitude
Call:
lm(formula   =   BoroughRegionParkScore$meanAverag.x   ~
BoroughRegionParkScore$meanLat.x)

Residuals:
    Min      1Q  Median      3Q     Max 
-2.8921 -1.0783 -0.0489  0.9564  4.8124 

Coefficients:
                                 Estimate  Std.  Error  t
value Pr(>|t|)    
(Intercept)                          0.74197     0.71828
1.033    0.302    
Mean Latitude                     0.05511         0.01357
4.061 4.99e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1
' ' 1

Residual standard error: 1.393 on 3524 degrees of freedom
Multiple R-squared:  0.004658,     Adjusted    R-squared:
0.004376 
F-statistic: 16.49 on 1 and 3524 DF,  p-value: 4.992e-05
```



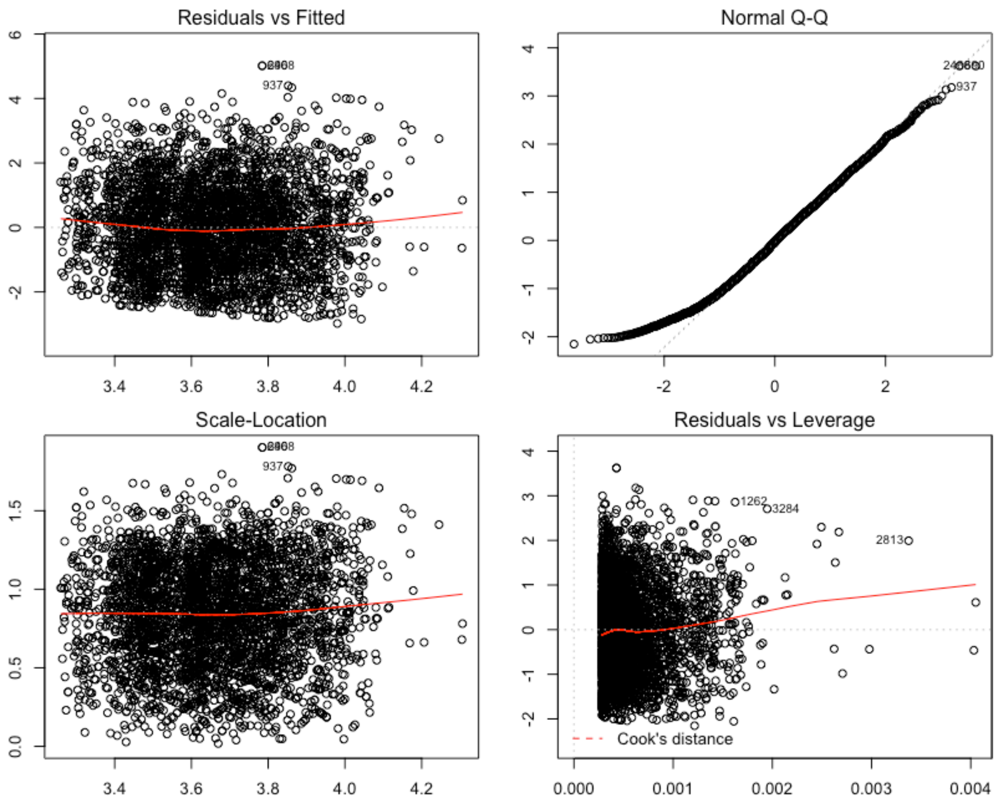

```
Longitude
lm(formula    =    BoroughRegionParkScore$meanAverag.x    ~
BoroughRegionParkScore$meanLon.x)

Residuals:
    Min      1Q   Median      3Q     Max
-2.9803 -1.0788 -0.0522  0.9512  5.0154

Coefficients:
                                 Estimate  Std.  Error  t
value Pr(>|t|)
(Intercept)                          3.45907     0.03491
99.089  < 2e-16 ***
Mean Longitude                    -0.11420     0.01496   -
7.635 2.89e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1
' ' 1

Residual standard error: 1.385 on 3524 degrees of freedom
```

```
Multiple R-squared:  0.01627, Adjusted        R-squared:
0.01599
F-statistic: 58.29 on 1 and 3524 DF,  p-value: 2.894e-14
```

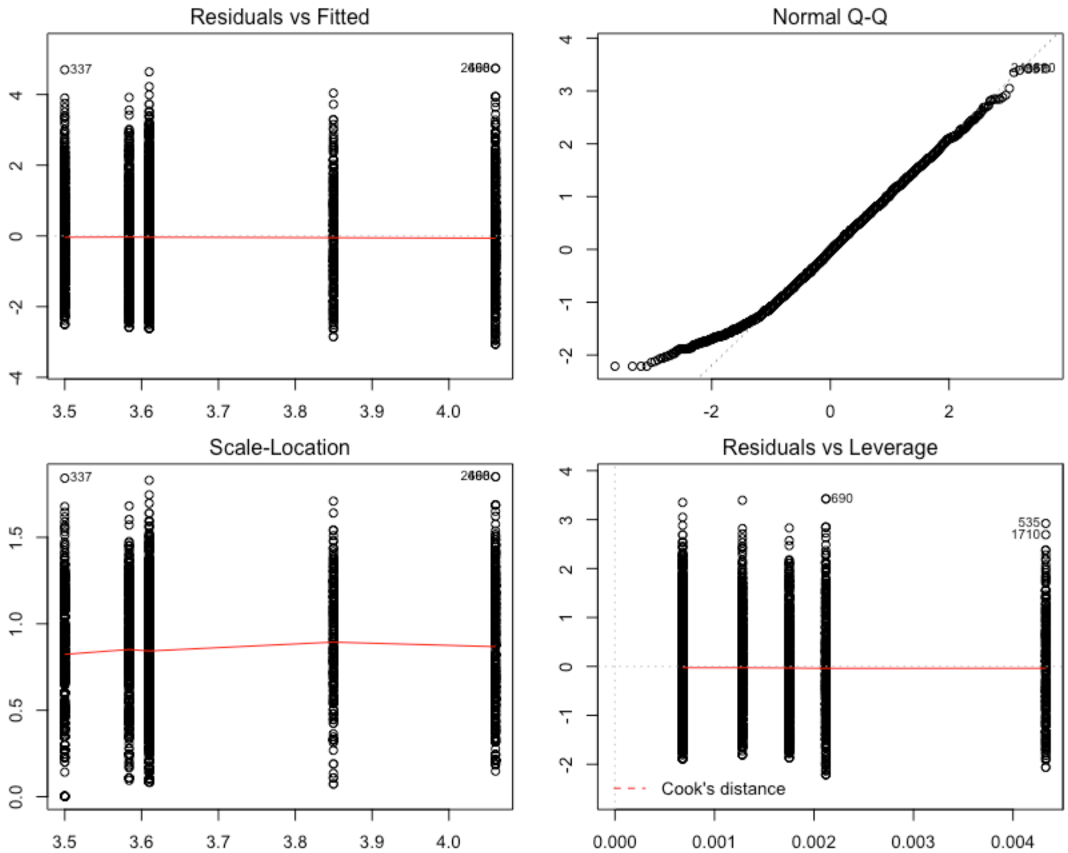



```
Region
Call:
lm(formula    =    BoroughRegionParkScore$meanAverag.x   ~
BoroughRegionParkScore$Region)

Residuals:
    Min      1Q   Median      3Q     Max
-3.0606 -1.0606 -0.0385  0.9496  4.7394

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)      4.06057    0.06378  63.665  < 2e-16 ***
RegionNorth     -0.56058    0.08079  -6.939 4.68e-12 ***
RegionWales     -0.21093    0.11127  -1.896   0.0581 .
RegionMidlands  -0.47679    0.08620  -5.531 3.41e-08 ***
RegionSouth     -0.45066    0.07330  -6.148 8.72e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1
' ' 1
```

```
Residual standard error: 1.386 on 3521 degrees of freedom
Multiple R-squared:  0.01616, Adjusted        R-squared:
0.01504
F-statistic: 14.46 on 4 and 3521 DF,  p-value: 1.035e-11
```



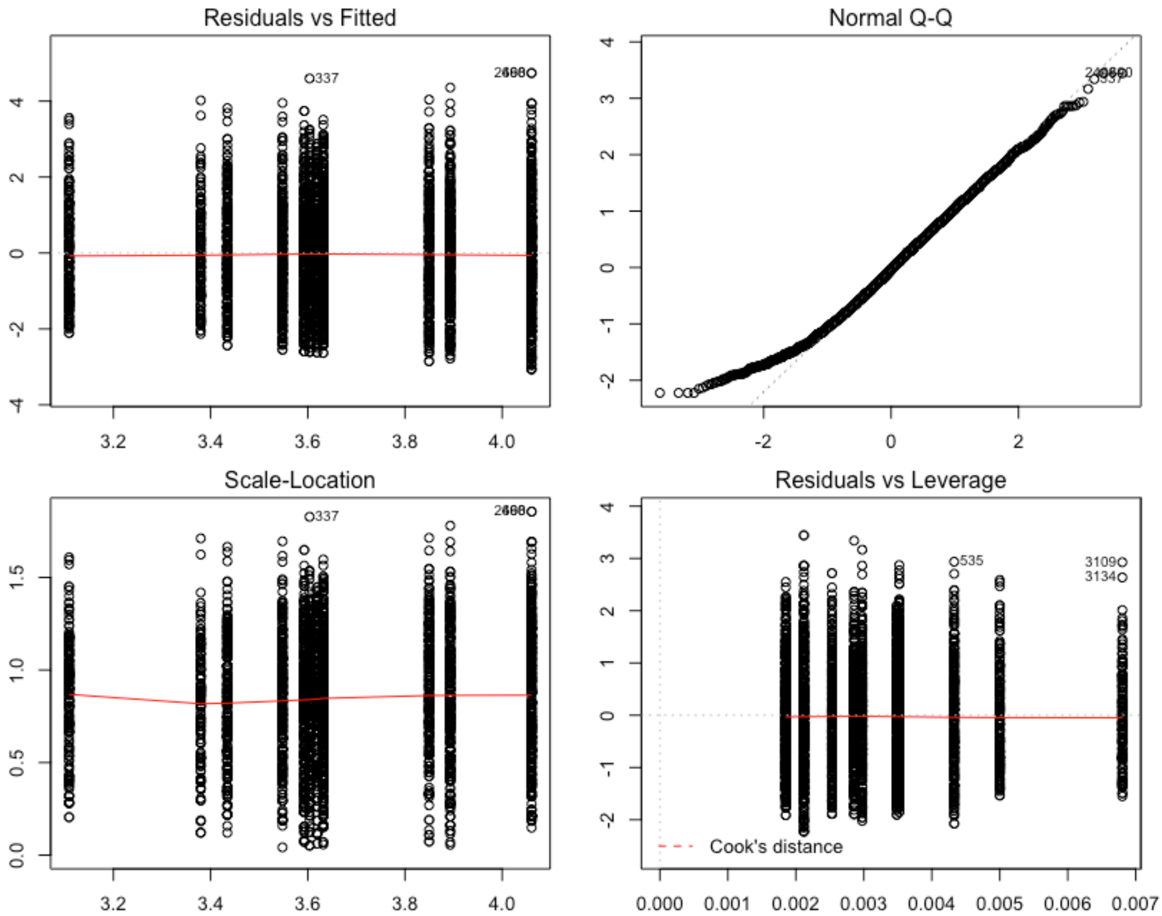
```
Euro Region
Call:
lm(formula   =   BoroughRegionParkScore$meanAverag.x   ~
BoroughRegionParkScore$NAME.y)

Residuals:
    Min      1Q  Median      3Q     Max
-3.0606 -1.0604 -0.0602  0.9516  4.7394

Coefficients:

                                      Estimate Std. Error
                                   t value Pr(>|t|)
(Intercept)                             4.06057    0.06343
64.016  < 2e-16 ***
North West Euro Region                 -0.45686    0.09721
-4.700 2.70e-06 ***
North East Euro Region                 -0.68084    0.13016
-5.231 1.79e-07 ***
Yorkshire and the Humber Euro Region -0.62617    0.10349
-6.050 1.60e-09 ***
West Midlands Euro Region              -0.44134    0.10315
-4.279 1.93e-05 ***
East Midlands Euro Region              -0.51262    0.10349
-4.953 7.64e-07 ***
Wales Euro Region                      -0.21093    0.11065
-1.906   0.0567 .
South West Euro Region                 -0.16737    0.09836
-1.702   0.0889 .
Eastern Euro Region                    -0.46791    0.09397
-4.979 6.70e-07 ***
London Euro Region                     -0.95173    0.11627
-8.186 3.75e-16 ***
South East Euro Region                 -0.42874    0.08683
-4.937 8.28e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1
' ' 1

Residual standard error: 1.378 on 3515 degrees of freedom
Multiple R-squared:  0.02858, Adjusted        R-squared:
0.02582
F-statistic: 10.34 on 10 and 3515 DF,  p-value: < 2.2e-16
```



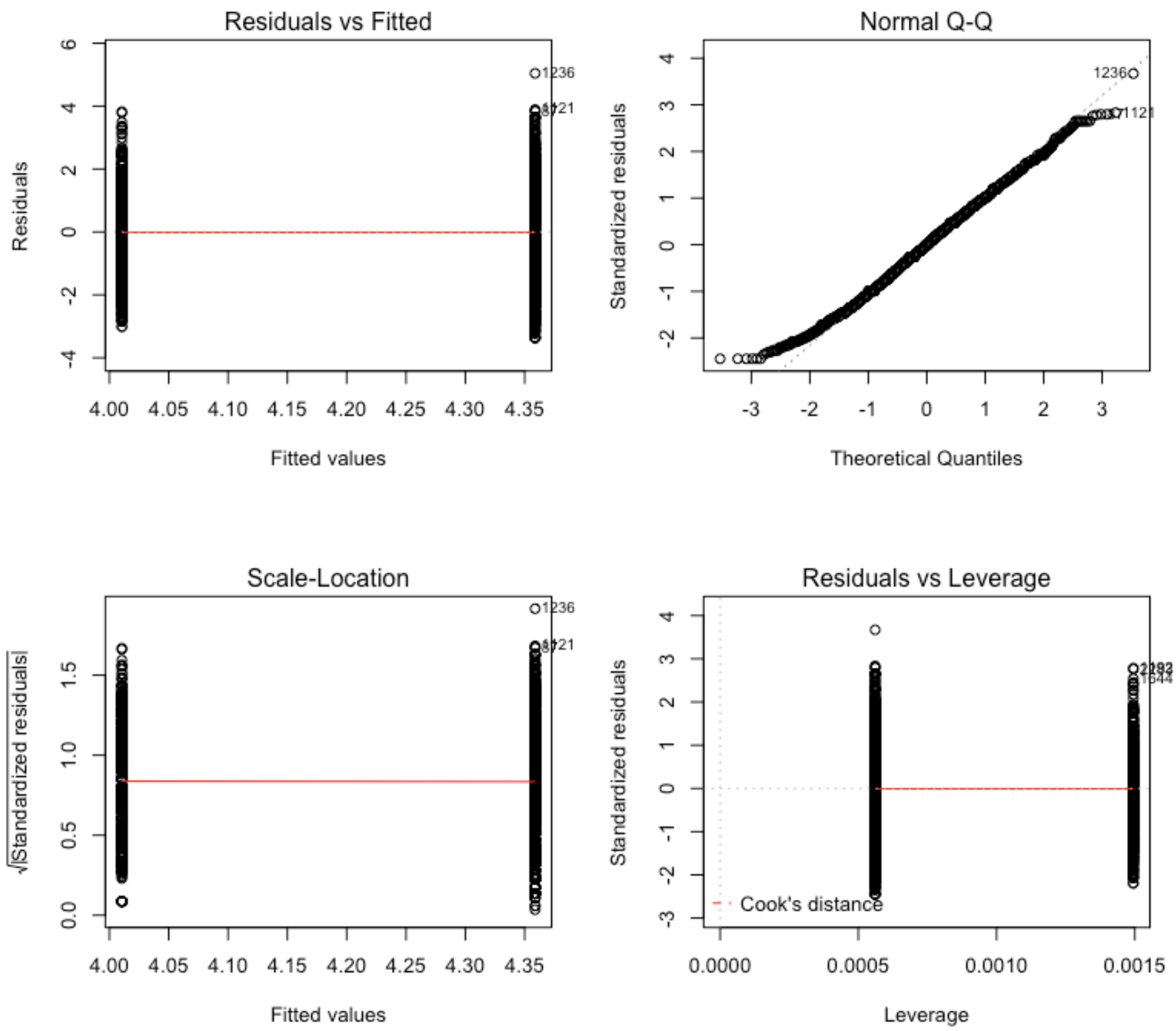

```
Call:
lm(formula = CityScore$AveVote ~ CityScore$RuralUrban)

Residuals:
    Min      1Q  Median      3Q     Max
-3.3588 -1.0105 -0.0105  0.9745  5.0412

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           4.35878    0.03254 133.963  < 2e-16
***
Urban                -0.34828    0.06229  -5.591 2.51e-08
***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1
' ' 1

Residual standard error: 1.374 on 2450 degrees of freedom
```

```
Multiple R-squared:  0.0126,  Adjusted R-squared:  0.0122
F-statistic: 31.26 on 1 and 2450 DF,  p-value: 2.506e-08
```



Appendix 3.1: Poster advertising survey

Survey of preferences in parks and greenspaces

WARWICK
THE UNIVERSITY OF WARWICK

Your opinions about parks and greenspaces are sought for a study at the University of Warwick.

The survey is completely anonymous and should take around 7 minutes to complete.

It can be accessed by using either of the addresses below, or by scanning the QR code at the bottom right of this page on your mobile or tablet.

If you have any questions about this research, please contact: [redacted]

Shorter link:
https://tinyurl.com/ybyq32kk

Full link:
http://warwick.co1.qualtrics.com/jfe/form/SV_2h78QyLGbpwX2ER

Appendix 3.2: Tweet advertising survey

[redacted]

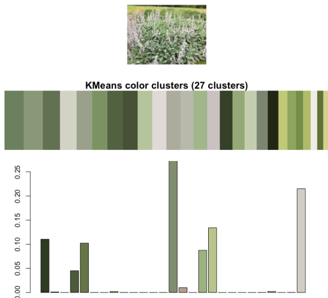
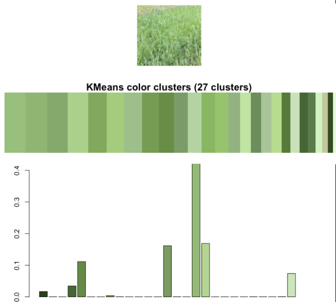
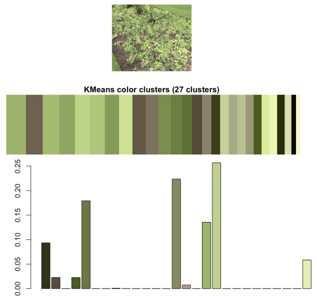
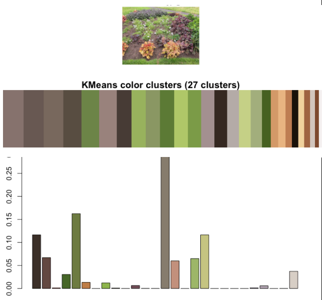
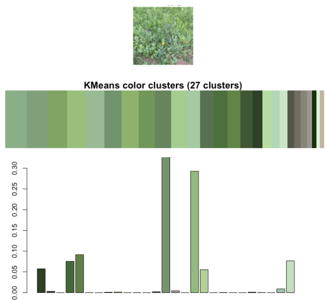
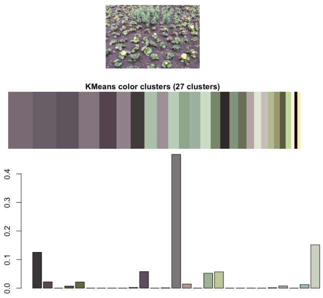
Please fill out this survey relating to preferences in parks and green spaces. It should only take 5-7 minutes and will help with research about the management of parks. Please share. warwick.co1.qualtrics.com/jfe/form/SV_2h...

12:16 PM · Jul 25, 2018 · Twitter Web Client

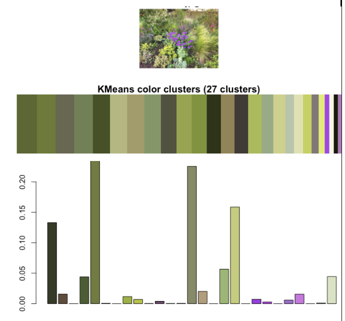
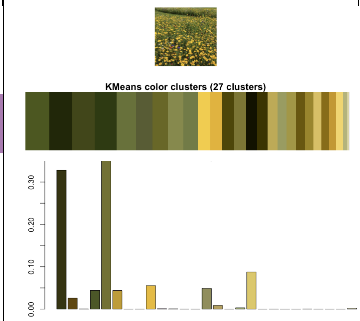
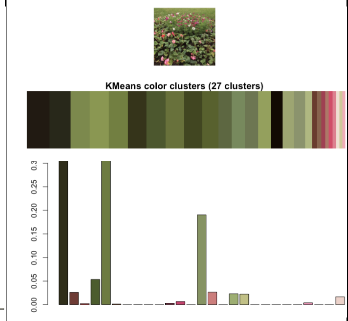
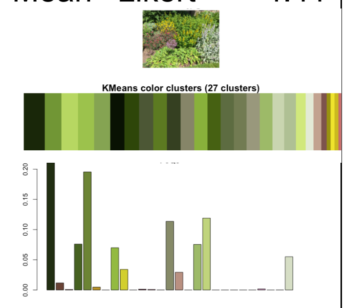
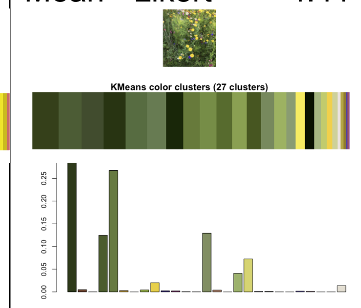
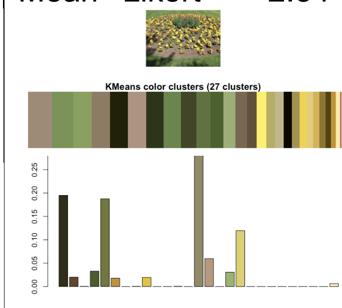
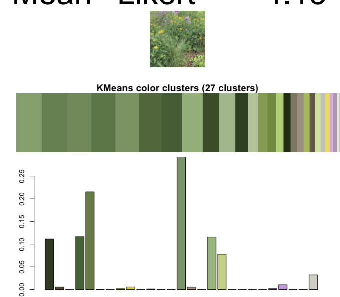
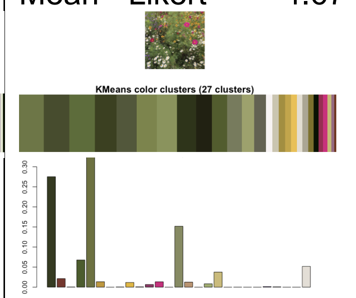
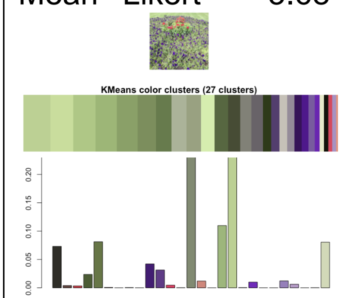
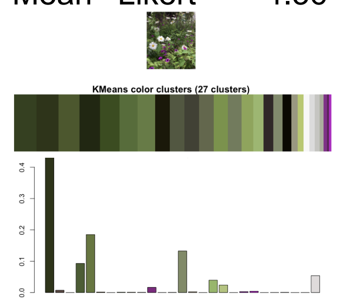
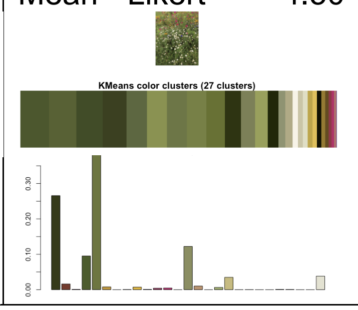
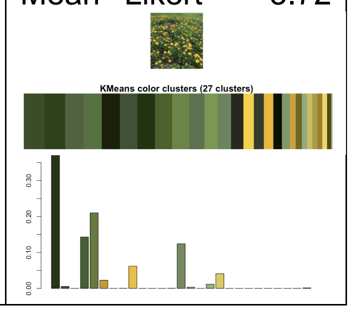
Appendix 3.3: Colour plots

The plots below show colour breakdown of the photos, using KMeans and binned histograms. Mean scores are included to give a rough measure of preference, though mean is not necessarily an accurate measure due to the ordinal nature of the data.

Not yet in full bloom Likert

Q	Perennial bedding	Pictorial Meadows	Seasonal bedding
2	Mean Likert = 3.85 	Mean Likert = 3.44 	Mean Likert = 2.46 
3	Mean Likert = 3.51 	Mean Likert = 3.43 	Mean Likert = 2.24 

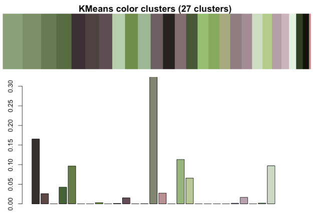
Full bloom Likert

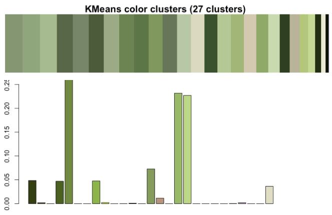
Q	Perennial bedding	Pictorial Meadows	Seasonal bedding
4	Mean Likert = 4.51 	Mean Likert = 4.36 	Mean Likert = 3.83 
5	Mean Likert = 4.41 	Mean Likert = 4.41 	Mean Likert = 2.84 
6	Mean Likert = 4.13 	Mean Likert = 4.67 	Mean Likert = 3.68 
7	Mean Likert = 4.36 	Mean Likert = 4.50 	Mean Likert = 3.72 

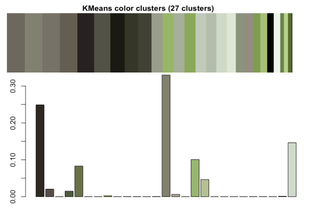
Rank photos

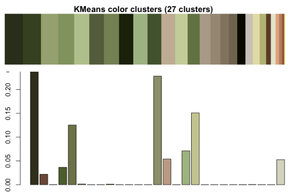
Not yet in full bloom rank

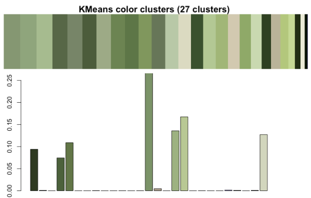
<table>
<tr><th>Q</th><th>Perennial bedding</th><th>Pictorial Meadows</th><th>Seasonal bedding</th></tr>
<tr><td>9</td><td>Mean rank = 1.57

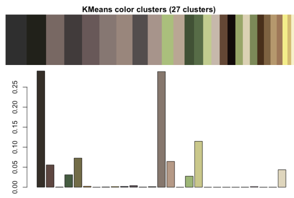

</td><td>Mean rank = 1.84


</td><td>Mean rank = 2.58

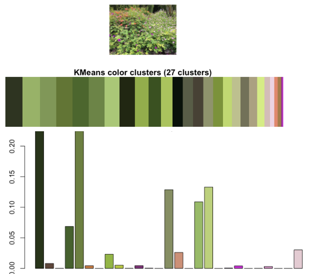
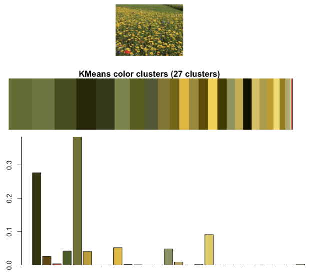
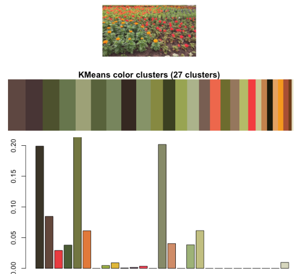
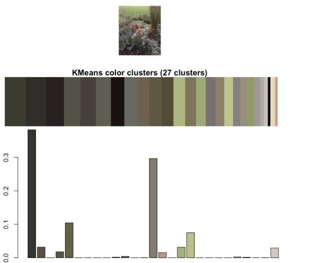
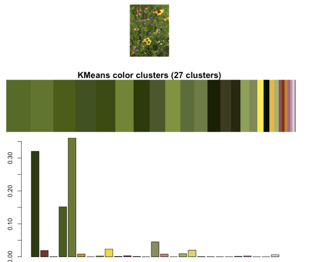
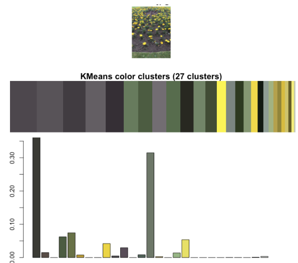
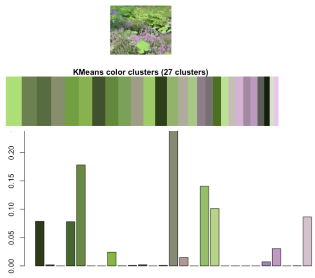
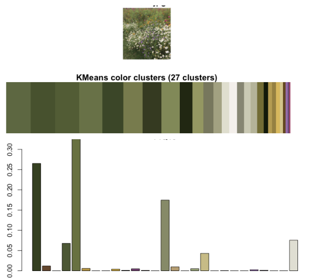
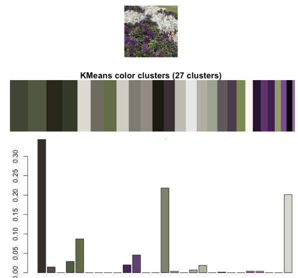

</td></tr>
<tr><td>10</td><td>Mean rank = 1.45


</td><td>Mean rank = 1.93

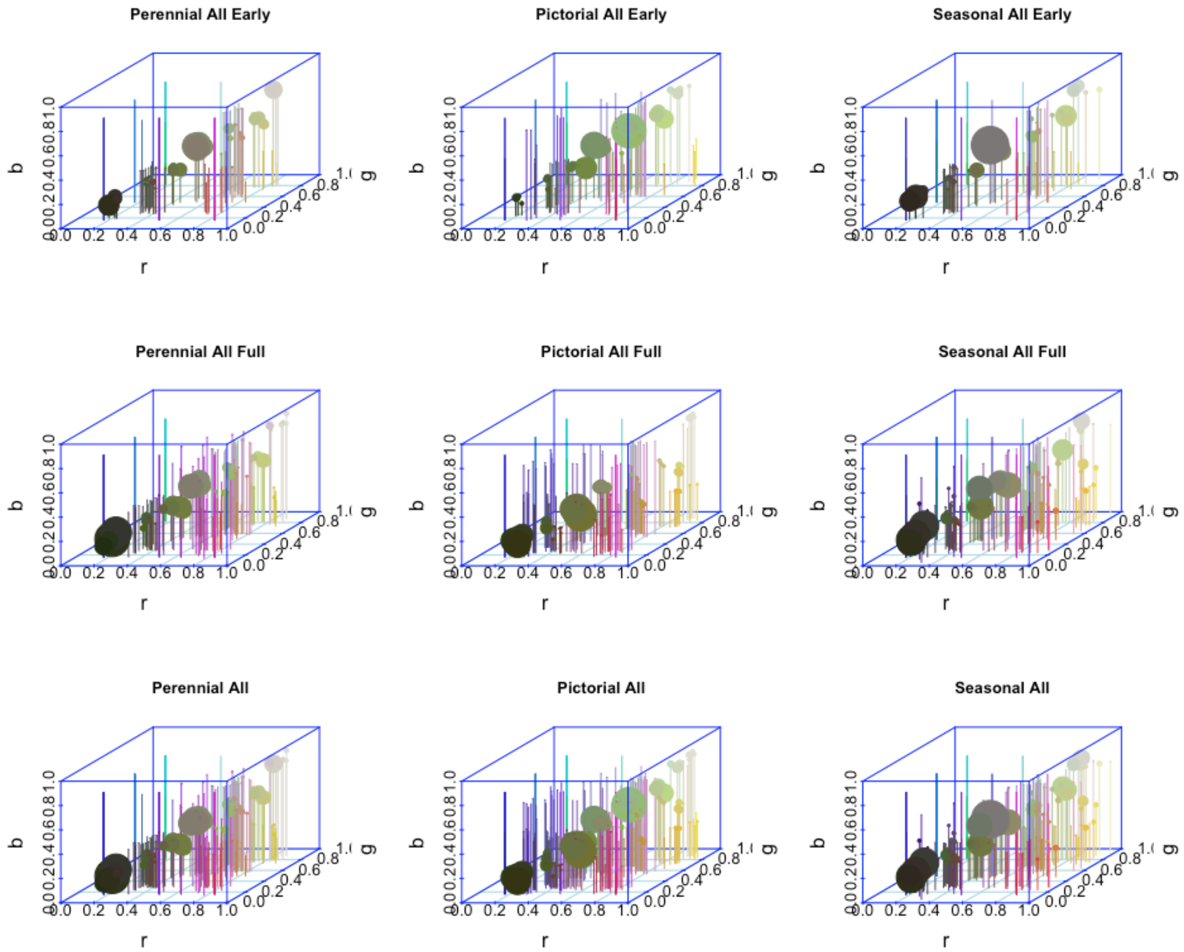

</td><td>Mean rank = 2.61


</td></tr>
</table>

Full bloom rank

Q	Perennial bedding	Pictorial Meadows	Seasonal bedding
11	Mean rank = 1.80 	Mean rank = 1.74 	Mean rank = 2.46 
12	Mean rank = 1.92 	Mean rank = 1.39 	Mean rank = 2.69 
13	Mean rank = 2.01 	Mean rank = 1.65 	Mean rank = 2.34 

Colour 3D plots



3D plots of the colours found in the images in survey, top row show the image histograms, based on 27 bins.

Appendix 3.4: Internal consistency

Perennial early
Estimates assuming interval level:
Spearman Brown coefficient: 0.14
Cronbach's alpha: 0.14
Pearson Correlation: 0.08

Perennial full bloom
Estimates assuming ordinal level:
Ordinal Omega (total): 0.68
Ordinal Omega (hierarch.): 0.67
Ordinal Cronbach's alpha: 0.64
Confidence intervals:
Ordinal Omega (total): [0.61, 0.75]
Ordinal Cronbach's alpha: [0.56, 0.72]

All Perennial
Estimates assuming ordinal level:
Ordinal Omega (total): 0.66
Ordinal Omega (hierarch.): 0.65
Ordinal Cronbach's alpha: 0.64
Confidence intervals:
Ordinal Omega (total): [0.59, 0.72]
Ordinal Cronbach's alpha: [0.57, 0.72]

Pictorial early
Estimates assuming interval level:
Spearman Brown coefficient: 0.65
Cronbach's alpha: 0.65
Pearson Correlation: 0.48

Pictorial full bloom
Estimates assuming ordinal level:
Ordinal Omega (total): 0.74
Ordinal Omega (hierarch.): 0.73
Ordinal Cronbach's alpha: 0.71
Confidence intervals:
Ordinal Omega (total): [0.68, 0.79]
Ordinal Cronbach's alpha: [0.64, 0.77]

All pictorial
Estimates assuming ordinal level:
Ordinal Omega (total): 0.73
Ordinal Omega (hierarch.): 0.71

Ordinal Cronbach's alpha: 0.73
Confidence intervals:
Ordinal Omega (total): [0.68, 0.78]
Ordinal Cronbach's alpha: [0.67, 0.78]

Seasonal early
Estimates assuming interval level:
Spearman Brown coefficient: 0.63
Cronbach's alpha: 0.62
Pearson Correlation: 0.46

Seasonal full bloom
Estimates assuming ordinal level:
Ordinal Omega (total): 0.76
Ordinal Omega (hierarch.): 0.75
Ordinal Cronbach's alpha: 0.75
Confidence intervals:
Ordinal Omega (total): [0.7, 0.81]
Ordinal Cronbach's alpha: [0.69, 0.8]

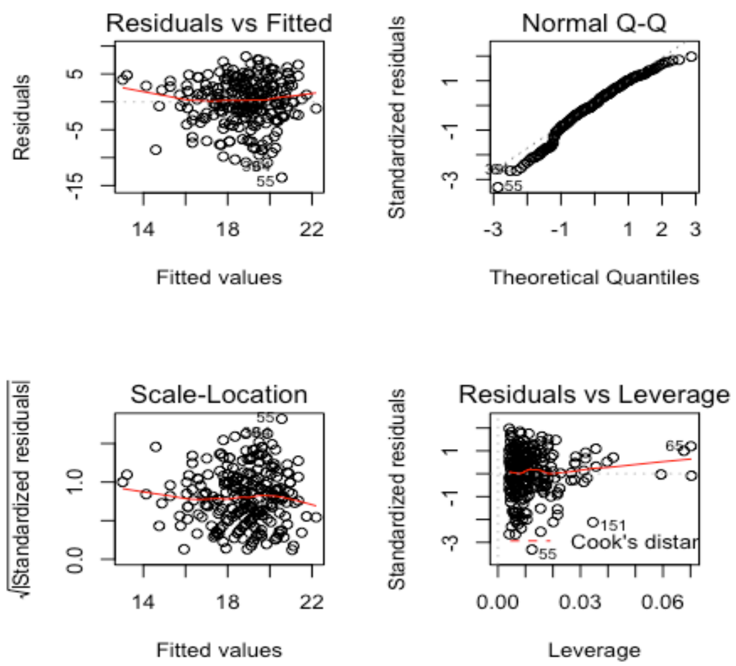
All seasonal
Estimates assuming ordinal level:
Ordinal Omega (total): 0.79
Ordinal Omega (hierarch.): 0.78
Ordinal Cronbach's alpha: 0.78
Confidence intervals:
Ordinal Omega (total): [0.74, 0.83]
Ordinal Cronbach's alpha: [0.74, 0.83]

Note: the normal point estimate and confidence interval for omega are based on the procedure suggested by Dunn, Baguley & Brunsden (2013) using the MBESS function ci.reliability, whereas the psych package point estimate was suggested in Revelle & Zinbarg (2008). See the help ('?scaleStructure') for more information.

Appendix 3.5: Regressions

```
lm(formula = Summed$Seasonal ~ Summed$Pictorial + Summed$Perennial)
Residuals:
     Min       1Q   Median       3Q      Max
-13.5654  -2.1288   0.3143   2.9407   8.1310
Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)       9.05369    2.34516   3.861 0.000145 ***
Summed$Pictorial -0.22780    0.09751  -2.336 0.020307 *
Summed$Perennial  0.62041    0.10878   5.704 3.42e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.119 on 241 degrees of freedom
Multiple R-squared:  0.1241,	Adjusted R-squared:  0.1168
F-statistic: 17.07 on 2 and 241 DF,  p-value: 1.166e-07
```



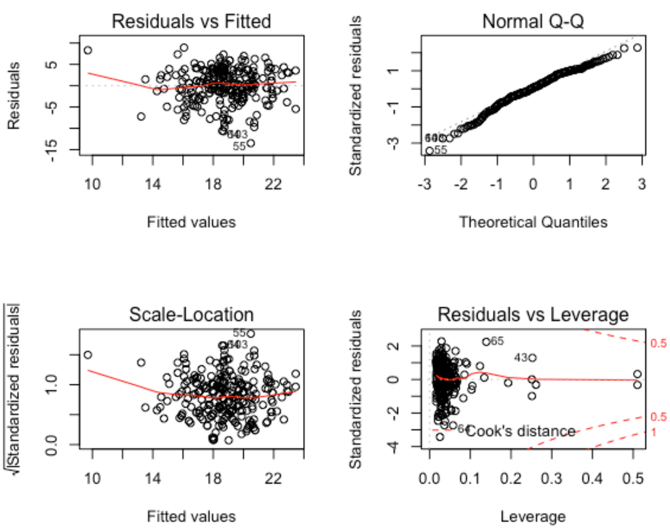
Age

```
lm(formula = Summed$Seasonal ~ Summed$Perennial * Summed$Pictorial +
ordered(Summed$AgeN))

Residuals:
     Min       1Q   Median       3Q      Max
-13.4850  -2.0824   0.2748   3.0681   8.9323

Coefficients:
                              Estimate Std. Error t value Pr(>|t|)
(Intercept)                   44.74463   13.17516   3.396 0.000803 ***
Summed$Perennial              -0.97766    0.56211  -1.739 0.083311 .
Summed$Pictorial              -1.76823    0.55491  -3.187 0.001637 **
ordered(Summed$AgeN).L        -0.97855    2.03495  -0.481 0.631059
ordered(Summed$AgeN).Q         0.78428    2.00423   0.391 0.695922
ordered(Summed$AgeN).C         1.52313    1.63968   0.929 0.353893
ordered(Summed$AgeN)^4        -1.57866    1.20436  -1.311 0.191219
ordered(Summed$AgeN)^5        -0.27093    0.87442  -0.310 0.756956
ordered(Summed$AgeN)^6        -0.25660    0.69845  -0.367 0.713666
ordered(Summed$AgeN)^7         0.06009    0.64876   0.093 0.926288
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.985 on 233 degrees of freedom
Multiple R-squared:  0.2076,	Adjusted R-squared:  0.1736
F-statistic: 6.105 on 10 and 233 DF,  p-value: 2.988e-08
```



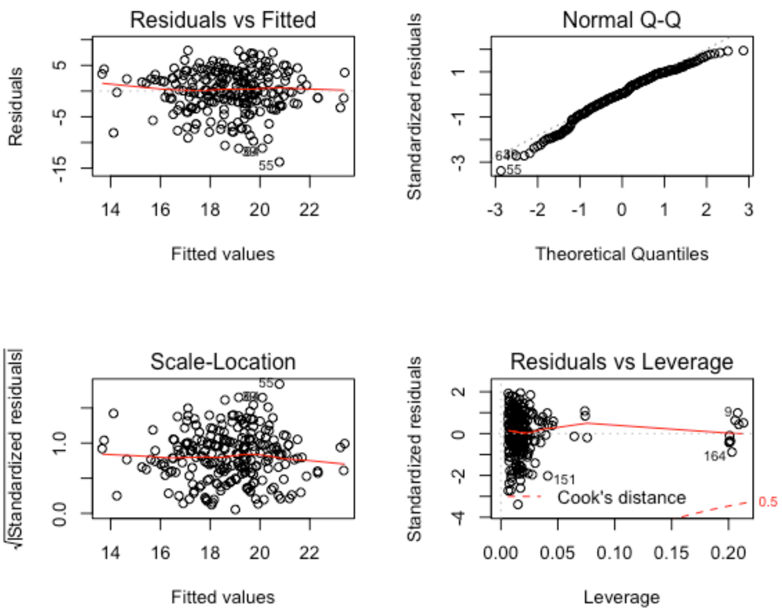
<u>Gender</u>

```
lm(formula = Summed$Seasonal ~ Summed$Perennial + Summed$Pictorial +
    Summed$Gender)

Residuals:
     Min       1Q   Median       3Q      Max
-13.7831  -2.2551   0.1685   3.0134   7.8907

Coefficients:
                              Estimate Std. Error t value Pr(>|t|)
(Intercept)                   10.09969    2.39713   4.213 3.57e-05 ***
Summed$Perennial               0.59023    0.10938   5.396 1.64e-07 ***
Summed$Pictorial              -0.22839    0.09743  -2.344   0.0199 *
Summed$GenderMale             -0.98960    0.56845  -1.741   0.0830 .
Summed$GenderOther            -0.46785    1.87404  -0.250   0.8031
Summed$GenderPrefer not to say  2.44697    1.87719   1.304   0.1937
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.101 on 238 degrees of freedom
Multiple R-squared:  0.1429,	Adjusted R-squared:  0.1248
F-statistic: 7.933 on 5 and 238 DF,  p-value: 6.228e-07
```



Appendix 3.6: Survey

Note that the survey was released online in Qualtrics so respondents saw a different format to that displayed here, with one question shown per page.

See over:

Welcome

This survey relates to your preferences in urban parks and other green spaces.

There are some questions about you, but none of your answers will be used to identify you, the survey is anonymous. All questions are optional and you can skip any of them if you wish, or leave the survey at any time.

The data will be used by the University of Warwick to investigate public preferences in green spaces. It will be stored online in the Qualtrics survey platform and downloaded to be analysed by the researchers involved in this study.

Most people take 7-10 minutes to complete the survey. Most of the questions just require you to click your choice. There are 14 questions with photos, followed by 7 questions about your opinions and 7 about you.

If you require any further information contact:
[redacted]

- ○ Please tick to confirm that you have understood the above and are happy to take part in this survey, then click next below to begin.

Park Features

Please rate the photos below, which show types of flower bed/floral display.
You can click on the photos to enlarge them.

	Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot
	○	○	○	○	○

	Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot
	○	○	○	○	○

	Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot
	○	○	○	○	○

Please rate the photos below, which show types of flower bed/floral

display.
You can click on the photos to enlarge them.

	Dislike a lot	Dislike a little	Neither like nor dislike	Like a little	Like a lot
	○	○	○	○	○

	Dislike a lot	Dislike a little	Neither like nor dislike	Like a little	Like a lot
	○	○	○	○	○

	Dislike a lot	Dislike a little	Neither like nor dislike	Like a little	Like a lot
	○	○	○	○	○

Please rate the photos below, which show types of flower bed/floral display.
You can click on the photos to enlarge them.

	Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot
					

	Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot
					

	Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot
					

Please rate the photos below, which show types of flower bed/floral display.
You can click on the photos to enlarge them.

	Dislike a lot	Dislike a little	Neither like nor dislike	Like a little	Like a lot

Dislike a lot	Dislike a little	Neither like nor dislike	Like a little	Like a lot

Dislike a lot	Dislike a little	Neither like nor dislike	Like a little	Like a lot

Please rate the photos below, which show types of flower bed/floral display.
You can click on the photos to enlarge them.

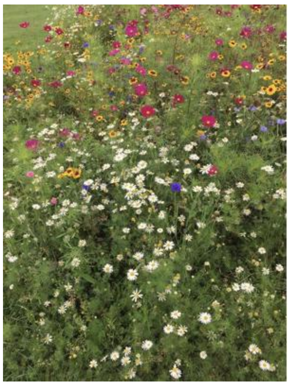
Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot

	Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot

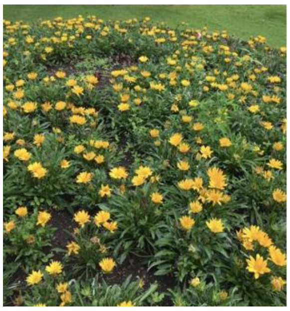
	Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot

Please rate the photos below, which show types of flower bed/floral display.
You can click on the photos to enlarge them.

	Dislike a lot	Dislike a little	Neither like nor dislike	Like a little	Like a lot



Dislike a lot	Dislike a little	Neither like nor dislike	Like a little	Like a lot



Dislike a lot	Dislike a little	Neither like nor dislike	Like a little	Like a lot

Please rate the photos below, which show types of grass/mowing. You can click on the photos to enlarge them.

Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot

Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot

Like a lot	Like a little	Neither like nor dislike	Dislike a little	Dislike a lot

Please rank the following photos, which show types of flower bed/floral display. 1 being your favourite, 3 your least favourite. You can click on the photos to enlarge them.

1 2 3

Please rank the following photos, which show types of flower bed/floral display. 1 being your favourite, 3 your least favourite. You can click on the photos to enlarge them.

	1	2	3
	○	○	○
	○	○	○

Please rank the following photos, which show types of flower bed/floral display. 1 being your favourite, 3 your least favourite. You can click on the photos to enlarge them.

1 2 3

○ ○ ○

○ ○ ○

Please rank the following photos, which show types of flower bed/floral display. 1 being your favourite, 3 your least favourite. You can click on the photos to enlarge them.

1 2 3

Please rank the following photos, which show types of flower bed/floral display. 1 being your favourite, 3 your least favourite. You can click on the photos to enlarge them.

1 2 3

Please rank the following photos, which show types of grass/mowing. 1 being your favourite, 3 your least favourite. You can click on the photos to enlarge them.

1 2 3

Please rank the following photos, which show types of

grass/mowing. 1 being your favourite, 3 your least favourite.
You can click on the photos to enlarge them.

	1	2	3
	○	○	○
	○	○	○
	○	○	○

About your favourites

Please briefly explain what you liked in the pictures in the survey so far.

Please briefly explain what you disliked in the pictures in the survey so far.

In any of the questions with photos, if you knew that a different photo to the one you chose was better for wildlife, especially insect pollinators such as bees, would this affect your choice?

- ◯ I would choose the same
- ◯ I would tend to make the choice that is better for wildlife
- ◯ I would tend to make the choice that is NOT better for wildlife

In any of the questions with photos, if you knew that a different photo to the one you chose was cheaper to plant and maintain would this affect your choice?

- ◯ I would choose the same
- ◯ I would tend to make a cheaper choice
- ◯ I would tend to make a more expensive choice

About parks

Consider urban parks and other green areas (such as cemeteries, sports grounds and nature areas) when answering the following questions.

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
They should be neat and formal	○	○	○	○	○
Wildlife should be encouraged	○	○	○	○	○
I enjoy features such as formal flower beds	○	○	○	○	○
I enjoy natural features such as wildflowers	○	○	○	○	○
All grass should be kept short	○	○	○	○	○
A mix of long and short grass is good	○	○	○	○	○
Long grass is good for most areas	○	○	○	○	○

About you

How often do you visit parks or other green places within urban areas? (Including other urban green spaces such as cemeteries, nature areas, public gardens).

- ◯ Daily
- ◯ 4-6 times a week
- ◯ 2-3 times a week
- ◯ Once a week or a few times per month
- ◯ Monthly
- ◯ Less than once a month
- ◯ Rarely
- ◯ Never

How do you use parks and other urban green areas? (tick all that apply)

- ☐ Exercise
- ☐ Play
- ☐ Enjoy wildlife
- ☐ Enjoy the scenery
- ☐ Dog walking
- ☐ Socialising
- ☐ Attend events
- ☐ Passing through
- ☐ Other

If you clicked other, please state other reason(s) you use parks.

How often do you visit the countryside or rural green places (outside of urban areas)?

- ◯ Daily
- ◯ 4-6 times a week
- ◯ 2-3 times a week
- ◯ Once a week or a few times per month
- ◯ Monthly
- ◯ Less than once a month
- ◯ Rarely
- ◯ Never

Are you interested in wildlife?

- ◯ Yes, very interested
- ◯ Somewhat interested
- ◯ Not interested

What type of area do you live in?

- Rural (in the countryside outside of village or town)
- Village (small settlement)
- Suburban (near the edge of town or city)
- Urban (town or city)

What type of job do you do (or did you previously do, if currently retired or unemployed)?

- Indoor
- Outdoor
- A mixture of indoor and outdoor work

What is your gender?

- Male
- Female
- Other
- Prefer not to say

How old are you?

- 12 and under
- 13 to 17
- 18 to 24
- 25 to 34

- 35 to 44
- 45 to 54
- 55 to 64
- 65 to 74
- 75 to 84
- 85 and over

For analysis purposes please give your home postcode (this will not be used to identify or contact you). Just give the first half if you prefer.
Please state home country if you don't live in the UK.

Do you have any other comments?

How did you hear about this survey?

- Twitter
- Facebook
- e-mail

- Poster
- SurveyCircle
- Other